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MEMOIRS OF THE QUEENSLAND MUSEUM, VOL. XII, PART III.

THE CAMBRIAN FAUNAS OF NORTH-EASTERN AUSTRALIA.

PART 5. THE TRILOBITE GENUS *DORYPYGE*.

BY F. W. WHITEHOUSE, PH.D., D.SC.
(MAJOR R.A.E.).

(Plate XI.)

EXPLANATION.

In Part 3 of this series of papers the polymerid trilobites that had been collected to that date (1939) were described. Since then, as noted in Part 4, very many more trilobites and other fossils have been collected from a series of beds ranging through most of the Middle Cambrian. These beds are exposed in the dissected hilly country east and north-east of Camooweal. Not only did this field excursion bring to light such new and very rich faunas, but for the first time a measured thickness of the beds was followed systematically and a zonal collection made. Previously all fossils had been gathered from widely separated localities, mainly from outcrops of flat beds appearing through the alluvium. The zonal nomenclature that was adopted in the earlier papers, therefore, was based purely on palaeontological evidence. Now, with a measured section as a basis, a direct zonal grouping is possible.

Systematic description of the zonal trilobite faunas (Miomera and Polymera) had begun before the outbreak of war. After my enlistment this had to be discontinued. At that time some of the plates had been prepared and some of the text written. But the only section that was complete, with text, text-figures and plates ready, was this small section on the trilobite genus *Dorypyge*. During a brief period of military leave this isolated fragment has been sent to the press in advance of the main body of the work which must wait until later.

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THE HORIZON OF THE *DORYPYGE* BEDS.

The genus *Dorypyge* is a new record for the Cambrian of Australia. When Part 3 was published the genera *Amphoton* and *Nepea* had been found (in association) at one locality only; and a zonal stage (*Amphoton* Stage) had been suggested for them. The subsequent collecting has shown that these two genera range through a considerable portion of the Middle Cambrian.

A lithological vertical section of the local Middle Cambrian limestones exposed along the Camooweal-Burketown road has been published (Whitehouse, 1940, p. 45), and the ranges of some of the trilobite genera indicated. Reference should be made to that for details. The sequence begins (in the late lower Cambrian) with limestones without trilobites. Then *Redlichia* appears, followed by *Xystridura* and other forms, these two genera overlapping for two feet in the section. Just as *Xystridura* dies out, about the end of the first third of the section, *Nepea* and *Amphoton* appear and range through the rest of the observed fossiliferous section. Half way through the range of these two genera the *Papyriaspis-Asthenopsis* fauna makes its appearance; and the species of *Dorypyge* have been collected in the beds containing all four genera towards the end of this faunal stage.

Without further elaboration, which must wait upon the publication of the other faunal evidence, the *Dorypyge* beds may be stated to occur near the top of the fossiliferous beds of this region. How far they are removed from the true top of the Middle Cambrian will not be discussed here.

Recently Resser (1939) has reviewed the Cambrian faunas of the Pacific region and, in my opinion, has overstated the relationships between Australia and Asia. He predicted the appearance, in the Middle Cambrian of Australia, of the curious genera that in present collections are endemic to the Chinese province. It may be stated that recent collecting still has not discovered these in Australia. Rather (as with the genus *Dorypyge*) the new faunas have intensified the common nature of this Province, with its commingling of Asiatic, Cordilleran and Atlantic types that, I suggested (1939, p. 269), was normal for the southerly position of Australia in the Cambrian—a suggestion that Resser seems to have overlooked.

The descriptions that follow were written early in 1941, since when I have been away from all palaeontological literature. Any foreign species of *Dorypyge* that may have been recorded since that date will therefore not be noticed in this paper.

DESCRIPTIONS.

Order Polymera Jaekel, 1909.

Suborder Corynexochida Kobayashi, 1935.

Family DORYPYGIDAE Kobayashi, 1935.

Genus **DORYPYGE** Dames, 1883.

Genotype: *Dorypyge richthofeni* Dames[1].

It is still difficult to decide the generic limits of *Dorypyge*. No complete test of any species of the genus has been figured, so that the number of segments in the thorax is unknown. For most species, too, the free cheeks and the hypostome have not been recorded. The genotype has a granulate test, six pairs of lateral, pygidial spines, but no spines on the axis of the pygidium. Most of the species that have been placed in *Dorypyge* in recent years have similar characters; but some forms so placed (e.g. *D. danica* Grönwall, 1902, p. 134, pl. 3, figs. 7-12) have a non-granulate surface while others (e.g. *D. oriens* Grönwall, 1902, p. 135, pl. 3, figs. 13-15) have axial pygidial spines as well as a smooth surface. There are more curious species with intermediate characters. *D. lakei* Cobbold[2], for instance, has axial spines, a finely granulate pygidium, granules on the fixed cheeks but, curiously enough, not on the glabella. Some of the smooth forms without axial spines on the pygidium, e.g. *Proetus slatkowskii* Schmidt which von Toll (1896, p. 33, pl. 2, figs. 1-10) referred to *Dorypyge*, are more likely members of the rather earlier genera *Kootenia* or *Notasaphus*.

[1] Dames, although not stating specifically that *D, richthofeni* was the genotype, described only this one species. He did, however, refer two American species to the genus—*Dicellocephalus quadriceps* Hall and *D. (?) gothicus* Hall. Clearly from his description he intended *richthofeni* as the type. This generally has been so regarded by all later workers; and formally it may be nominated as genotype.

[2] Cobbold, 1911, p. 287, pl. xxv, figs. 1-8. See also Lake, 1938, p. 255, pl. xxxvi, figs. 2-12.

At the present time it would be preferable to use the name *Dorypyge* with hesitation for late Middle Cambrian species that have non-granulate tests or axial pygidial spines. Of the remaining forms that, with more confidence, may be left in *Dorypyge* the genotype, *D. richthofen* Dames (1883, p. 24, pl. 1, figs. 1-6), has the most primitive characters, in that there are traces of glabellar furrows, while the lateral ribs of the pygidium are divided by grooves that Lake (1938, p. 251) satisfactorily interprets as rudiments of the original pleural sutures.

Attention may be called to the pair of pits on the axial furrow of the cephalon of most species of *Dorypyge*. Pits in this anterior position, near the junction of the axial furrow and the palpebral ridges, are known in many trilobites. In certain forms, for instance *Dinesus* and the members of the family Nepeidae, anterior grooves radiate from these portions. Such pits or grooves on the surface become elevations on the inside of the test and I would suggest that, like the structures in the axial furrows of the thorax of many trilobites, they mark the place of attachment of muscles. One possible explanation is that they represent the places where the muscles controlling the antennules were attached. One specimen of *Dorypyge tenella* in the present collection is known from an excellent ventral surface of the head; and on it the centre of each elevation (that corresponds ventrally to the pit) bears a central depression.

The species of *Dorypyge* now recorded from Australia are a species group with similarities in such features as the more strongly accentuated fifth pair of pygidial spines and the presence of a sixth (posterior) pair that are mere rudiments. As a group it most closely resembles the Asiatic (Chinese and Manchurian) forms.

It is reasonable to suggest that *Dorypyge* and the similar forms of the later Middle Cambrian with axial spines on the pygidium may be the descendants of *Kootenia* and *Notasaphus* of the early Middle Cambrian. In those two genera, as previously noted (Whitehouse, 1939, p. 241), the stock seems to have differentiated into at least two groups—one (*Notasaphus*) without axial spines on the pygidium and another (*Kootenia*) having such spines. *Dorypyge* therefore may be the successor of *Notasaphus;* and the unnamed group typified by *D. lakei* may be more allied to *Kootenia.* Other variants (e.g. *D. oriens*) seem to have affinities with still other members of that rather variable earlier group. If so, the whole Middle Cambrian assemblage (Dorypygidae) may represent a gradually diverging stock of related forms.

DORYPYGE TENELLA sp. nov.

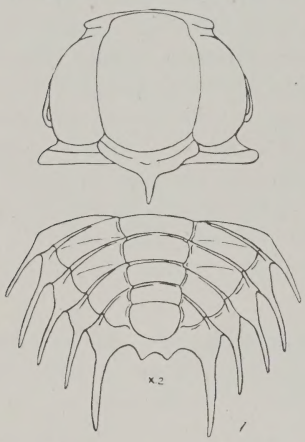
(Pl. XI, figs. 1-5.)

Diagnosis: Cranidium and pygidium ornamented with very fine, closely packed, hollow granules that, however, are absent from the furrows.

The cranidium is subquadrate with a slightly convex anterior margin. The glabella, which is inflated and unfurrowed, has sides that are parallel or only very slightly divergent and a sharply truncate anterior; it reaches almost to the anterior border, the anterior rim being particularly narrow; the axial

furrow is well incised and bears a pair of small pits at the anterior angles. The occipital ring bears a prominent, narrow, hollow spine. The fixed cheeks, in the central region, are slightly more than half as wide as the glabella; the palpebral lobes are only slightly curved, medianly situated and are about half the length of the cephalon; the palpebral ridges are very faint, converging on the anterior corners of the glabella. The anterior limbs of the facial suture are subparallel; the posterior limbs diverge but, near the palpebral lobe, they are subparallel to the posterior cephalic margin.

The pygidium is subtriangular to subcircular in outline. The axis has five segments, the posterior segment being semi-circular in outline and, in the adult forms, is not prominently marked from the one before it. There are five pairs of lateral ribs that are well rounded and sharply separated by narrow furrows. Oblique furrows on the crests of these ribs can faintly be seen on some specimens. There are six pairs of hollow, marginal spines, five of these are long and slender and arise rather abruptly from the lateral ribs while the sixth or posterior pair is but faintly indicated and is situated axially. The four anterior pairs of marginal spines are subequal in size; but the fifth pair is longer and thicker. Each spine arises from a rather thickened base. The doublure of the pygidium is narrow, wire-like, and of uniform width.



No other parts of the test are known with certainty.

Remarks: Fragments of this species representing 15 heads and 20 tails have been examined. Because of the hollowness of the granules, the ventral surface of the test is correspondingly pitted; and on a slightly abraded test the dorsal side may appear finely perforate.

There are a number of species, like *D. tenella,* in which the fifth pair of pygidial spines only are of exceptional size. Of these the most similar forms are the genotype *D. richthofeni* Dames (1883, p. 24, pl. 1, figs. 1-6), *D. pergranosa* Resser and Endo (1937, p. 210, pl. 31, figs. 6-13) and *D. matsushitai* Resser and Endo (1937, p. 210, pl. 43, figs. 22-23). These are the species, all of them from China and Manchoukuo, with which comparison is most pertinent. They have, also, in common with certain other species, the prominent pair of pits at the anterior angles of the cephalic axial furrow. *D. richthofeni* is easily distinguishable by the presence of glabellar furrows and by the coarser ornament. *D. pergranosa* is the most similar species and, indeed, *D. tenella* is to be separated from it only by minor though constant criteria. In general there is a most close agreement between these two species in outline, degree of granulation, type of pygidial spines, and the furrows of the pygidium. *D. tenella,* however, has facial sutures rather more parallel anteriorly, the pygidial spines arise a little more abruptly, and the furrow between the two posterior axial

segments of the pygidium is constantly shown, even though it is faint in the adult—this furrow seems to be eliminated in *D. pergranosa*. Furthermore there seems to be no trace of the faint oblique grooves on the crests of the lateral pygidial ribs in the latter form[3]. *D. matsushitai* differs slightly in the outline of the pygidium.

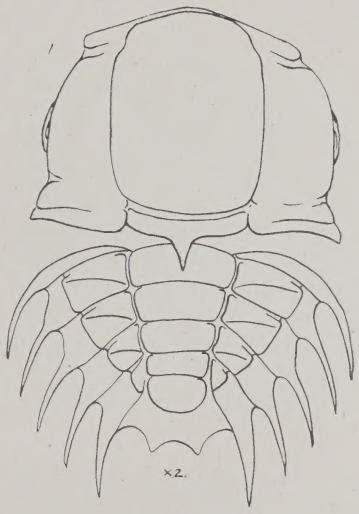
Locality: From beds about four miles east of Douglas Creek on the old Burketown road. (This locality is about three-quarters of a mile west of the type locality for *Anomocare confertum*).

DORYPYGE CORUSCA sp. nov.

(Pl. XI, figs. 8-13.)

Diagnosis: Cranidium and pygidium ornamented with very fine, closely set granules, similar in number and grouping to those of *C. tenella*.

The cranidium is rhomboidal in outline with subangular front. The glabella is subovate, reaching almost to the anterior margin of the head, the sides converging slightly in the anterior region; the axial furrow has a pair of pits at the anterior angles; the occipital ring bears a prominent, hollow spine. The fixed cheeks are narrow (a little less than one-half of the width of the glabella in the central region); the palpebral lobes are long and only slightly curved. The anterior limbs of the facial sutures converge slightly, the posterior limbs are oblique.



The pygidium is subtriangular in outline. The axis has five segments and there are five pairs of lateral ribs that have shallow, oblique furrows on their crests. The last transverse furrow in the axis is not well defined. There are six pairs of marginal spines, the posterior (sixth) pair being very small, the others long. The fifth pair of spines are thicker than the others.

No other parts of the test are known.

Remarks: The material examined consists of fragments of five heads and nine tails.

The species is most similar to *D. tenella*, the chief distinguishing features being the more ovate glabella, the converging facial sutures, the wider axis of the pygidium and the more prominent furrowing of the crests of the pygidial ribs. In these features the species approaches *D. richthofeni* but it lacks the glabellar furrows.

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[3] That is, judging from the figures. The specific descriptions by Resser and Endo are very meagre.

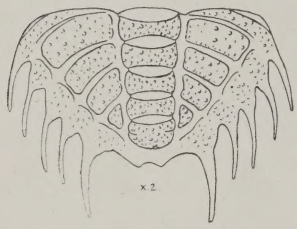
It would seem that the hollow granules are thinner than those of *D. tenella*, for, in most specimens examined, they are worn off leaving pitted surfaces, whereas in *D. tenella* such pitted surfaces were only rarely observed.

Locality and horizon: About three miles east of Douglas Creek on the old Burketown road.

DORYPYGE DECORIS sp. nov.

(Pl. XI, fig. 7.)

Diagnosis: Pygidium subsemicircular in outline, ornamented on the ribs, axial rings and border with relatively widely spaced granules that vary in size. The axis tapers very slowly and is divided into five rings by prominent furrows, the first three of which are relatively wide. The posterior ring is bulb-like and has a faint transverse furrow. There are five pairs of lateral ribs that extend to a wide and prominently differentiated border over which they are faintly continuous to end in long, fine, spines, the posterior pair of spines being rather thicker than the others. From the contours of the one incomplete specimen a sixth (posterior) pair of rudimentary spines is suspected. The crests of the lateral ribs do not bear oblique grooves.



Remarks: Only one specimen, a pygidium, has been collected. The species differs from the two previously described (*D. tenella* and *D. corusca*) in the less tapering axis, the coarser and more widely spaced granules and the wider axial furrows. In granulation and furrows it is somewhat like *D. damesi* Resser and Endo (1937, p. 209, pl. 31, figs. 14-18) but has a narrow, less tapering axis.

Locality and horizon: About three miles east of Douglas Creek on the old Burketown road.

DORYPYGE sp. ind.

(Pl. XI, fig. 6.)

A fourth species is represented by a fragmentary pygidium that differs from the other three species in having narrower lateral areas with more highly arched ribs.

Locality and horizon: From limestones at the junction of Bull Creek and Douglas Creek.

1 a

2 a

3

4

5 a

6

1 b

2 b

7 a

5 b

7 b

8

10

11

13 b

9

12

13 a

Face page 122.

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EXPLANATION OF PLATE XI.

(All figures natural size except figs. 1b, 2b, 5b, 7b and 13b).

Figs. 1-5. *Dorypyge tenella* sp. nov.

1a, b. A cranidium (1b enlarged 3.5 diams.)

2a, b. A cranidium with the cranidium of an undescribed trilobite superposed (2b enlarged 3.5 diams.)

3. An internal view of a pygidium, showing the narrow, wire-like doublure.

4. A pygidium showing the rudimentary sixth pair of spines.

5a, b. (Holotype) A pygidium (5b enlarged 3.5 diams.)

All specimens from Middle Cambrian limestones about four miles east of Douglas Creek, on the old Burketown road (Horizon in the beds with *Papyriaspis*).

Fig. 6. *Dorypyge* sp. ind.

This poorly preserved pygidium is the only specimen known of this form.

From limestones at the junction of Bull and Douglas Creeks (Horizon approximately the same as figs. 1-5).

Figs. 7a, b. *Dorypyge decoris* sp. nov.

7b is enlarged 3.5 diams. On 7a this pygidium, which is the holotype and the only known specimen of the species, is seen superposed on a dorsal shield of *Papyriaspis lanceola* Whiteh.

Locality and horizon: As for figs. 1-5.

Figs. 8-13. *Dorypyge corusca* sp. nov.

8, 9. Crushed cranidia. Fig. 9 shows the occipital spine.

10-13. Pygidia. 11 shows the rudimentary sixth pair of spines. 13a, b, is the holotype (13b enlarged 3.5 diams.).

From limestones about three miles east of Douglas Creek on the old Burketown road (Horizon close to that of figs. 1-5).

Holotypes and figured specimens in the collections of the Department of Geology, University of Queensland.

THE PETROGRAPHY OF SOME QUEENSLAND OIL SHALES.

By A. W. Beasley, M.Sc.,
Department of Geology, University of Queensland.

(Plate XII and Two Text-figures.)

CONTENTS.

Introduction.

Technique in Preparation of Thin Sections.

Petrographic Descriptions.
- Alpha Torbanite.
- Carnarvon Creek Torbanite.
- The Narrows Oil Shale.
- Strathpine Oil Shale.

Conclusion.

Acknowledgments.

Bibliography.

INTRODUCTION.

"An oil shale is a sapropelic shale rich in organic matter that yields considerable artificial petroleum by distillation" (Twenhofel, 1932, p. 397). Within this definition are included what McKee (1925, p. 27) has called the "true oil shales," as well as the specialised group of algal sapropelic deposits known as the torbanites.

In Queensland such oil shales have been recorded from the Permian, the Jurassic, and the Tertiary. In the Permian three deposits have so far been found—viz., the Alpha, Carnarvon Creek, and Bowen River Coalfield deposits. In the Jurassic small lenses of oil shale have been recorded from some of the Walloon coal-mining areas on the Darling Downs and in the Rosewood-Laidley district. Oil shales have also been recorded from several of the Tertiary basins in the eastern part of the State and, in some of these, the deposits are known to be quite extensive.

No detailed petrographic description of any of these oil shales has previously been published. In fact, laboratory investigations in the past have been confined almost entirely to chemical analyses and distillation tests. This is unfortunate, for the petrological examination of an oil shale is equally as important as its chemical analysis, and is an essential requirement in its systematic study. The quality of an oil shale can, in fact, be determined from a study of its physical properties, since these depend upon the nature, percentages, and arrangement of the various organic and inorganic constituents. A microscopic examination, however, is necessary to determine this data, as well as to investigate the biological origin and the environmental conditions under which the oil shale was formed.

TECHNIQUE IN PREPARATION OF THIN SECTIONS.

For the preparation of thin sections of the oil shales described below the normal procedure in rock sectioning was found to be unsatisfactory, and the following technique had to be developed.

Slices which were cut parallel and at right angles to the bedding (for horizontal and vertical sections) were ground first with 100-hole London Emery, and then with Emery Flour in the ordinary manner. Owing to the soft nature of the oil shales, however, it was necessary to continue grinding in order to remove scratches with a very fine hone held in a sloping position and kept continually wet by playing a thin stream of water upon it. Finally, the surface was given a high polish with Goddard's plate powder, which is also an exceedingly fine abrasive. Then, to avoid harming the material by mounting directly in Canada balsam heated to a high temperature to drive off the volatiles, the Canada balsam was first cooked in the usual way, and allowed to cool. It was then very carefully reheated, and when just remelted the slab was mounted, rather more pressure than usual being applied to squeeze out air bubbles from the viscous balsam. In this way the oil shale was mounted without any damage being done to it. The same method was then followed again in grinding the mounted slab down to the required thinness. As this was of the order of 0·005 mm., considerable care had to be taken during the final grinding. It was also necessary to avoid a high temperature in attaching the cover-slip to the slide, but satisfactory results were obtained by heating at a very low temperature for a prolonged period. Finally, to avoid the possibility of future wrinkling of the very thin section, a flat weight was placed on the cover-slip for several days.

Text-figure 1.—Map showing geographical location of the Alpha, Carnarvon, The Narrows, and Strathpine deposits.

PETROGRAPHIC DESCRIPTIONS.

The oil shales on which the following descriptions are based have all received some official consideration during the war period as possible sources for the production of liquid fuel.

The samples that have been chosen for petrological study are believed to be fairly representative of the various deposits.

ALPHA TORBANITE.

General and Macroscopic.

Locality of sample chosen for study: Tommy Staines Gully, portion 4, parish of Avonmore, county of Drummond, approximately 35 miles S.S.E. of Alpha. Geological Horizon: ? Lower Bowen Series. Age: Lower Permian.

In the hand specimen this is a fine-grained, compact, homogeneous rock of dark brownish-black colour. It has a dull silky lustre, and a sub-conchoidal fracture. It is tough and massive, only indistinct traces of bedding being visible. It is comparatively soft, and gives a yellowish-brown streak. The specific gravity is 1·09. It ignites readily and burns with a bright flame, producing a waxy, aromatic odour.

From the above physical properties the hand specimen is identified as a medium-grade, dull melanocratic torbanite, adopting Dulhunty's (1943) classification.

Microscopic.

(Plate XII, figs. 1, 2.)

Horizontal and vertical sections of this rock have shown that it exhibits a definite microscopic structure. It is made up of translucent algal material, consisting mainly of gelosite and retinosite bodies, separated by films of opaque matrix. Estimations made, using the eye-piece micrometer, of the percentages of gelosite and retinosite present have given an average of 66 per cent. gelosite and 4 per cent. retinosite. This places the rock on the borderline between a medium-grade and high-grade torbanite.

In the vertical section the translucent bodies are elongated in shape, lying parallel to the bedding plane, and in most cases the collapsed central cavity of the algal colonies can clearly be seen. The ratio of length to thickness determined for a large number of these flattened bodies has been found to average about six to one.

In the horizontal section the translucent bodies are roughly rounded in shape, closely packed, and separated by opaque material. They show considerable variation in size, ranging in diameter from about 0·1 to 0·75 mm. Many of them have a series of bulges, which represent simple algal colonies, round their margins, and the bodies in such cases have something of a botryoidal appearance. Unlike spores they do not possess hard and well-defined margins, but tend to fray out into the opaque groundmass.

Apart from the variation in the size of the translucent bodies, the microscopic structure or fabric of the rock is uniform and it is essentially non-banded.

Under ordinary transmitted light the gelosite, which is by far the most abundant maceral in the rock, is pale yellow in colour and almost transparent. It has a low relief with the refractive index very close to that of Canada balsam.

It is anisotropic, and in the vertical section there are positions of extinction parallel and at right angles to the bedding plane, maximum illumination occurring at intermediate positions. In the vertical section it also shows a type of "cross hatching" or rectangular arrangement of polarisation laminae, the laminae appearing when the bedding plane makes an angle of about 27 degrees on either side of the vibration direction of one of the nicols. The angle between these laminae and the bedding plane has been found to be about 70 degrees. As each of the gelosite bodies behaves in a similar manner, they all show their polarisation laminae at the one time in the same direction, giving the effect of optical continuity. This seems to indicate, as Dulhunty (1939, p. 186) has suggested, that the pressure that flattened the translucent bodies parallel to the bedding was responsible for some form of internal strain in the gelosite, giving rise to its polarisation phenomena.

The retinosite is much less abundant than the gelosite. It is orange-yellow in colour and quite distinct from the pale yellow of the gelosite. It is also less transparent than gelosite, and has a slightly higher relief. In all of its other optical properties, however, it is similar to gelosite, and the difference between these two bodies thus is presumably biological rather than the result of varying conditions of preservation.

Both the gelosite and the retinosite bodies have been found to be partly replaced by chalcedony. The grains of chalcedonic silica usually occur in the central part of the bodies and take the form of irregular masses, which are elongate in vertical section and fill the spaces that represent the collapsed central cavities of the algal colonies.

The groundmass of the rock is partly made up of small amounts of the substance which Dulhunty (1939, p. 187) calls "humosite". It is deep brownish-red in colour only in the very thin marginal area of the section, elsewhere appearing quite opaque. It shows no definite habit or internal structure, and is distributed through the matrix in such a way that it seems to have been moulded round the gelosite and retinosite bodies. Unlike gelosite and retinosite it has a high relief and it is isotropic. From the general character and appearance of its irregular particles the humosite seems to be a solidified humic product of decomposition rather than some specific organic material.

Most of the matrix consists, however, of mineral matter to which Dulhunty has given the general name of "matrosite." It is homogeneous and opaque, and consists of very finely-divided clay together with a few very small crystals of pyrites. It forms only a small part of the rock, and in places the skeleton of this matrix becomes discontinuous and fragmentary.

Under a high magnification the gelosite and retinosite bodies show the internal biological structures recently described by Dulhunty (1944, p. 30), from which he concluded that they were fossil forms of a colonial unicellular alga closely related to the living *Botryococcus braunii.*

Chemical Analysis.

A proximate analysis of this sample has given the following result:—

Moisture at 105 deg. C.	1·1 %
Volatile Matter	75·7 %
Fixed Carbon	14·4 %
Ash	8·8 %

Chemically this indicates a good medium-grade to high-grade torbanite. The high percentage of volatiles is due to the large quantity of algal material present, while the low ash content reflects the small amount of mineral matter in the rock. As is the case with all melanocratic torbanites the ratio of volatiles to fixed carbon is less than 10 to 1.

CARNARVON CREEK TORBANITE.

General and Macroscopic.

Locality of sample chosen for study: Outcrop in southern gully on portion 2, parish of Aubrey, county of Consuelo, about half-a-mile east of Carnarvon Creek, approximately 120 miles north of Injune. Geological Horizon: Upper portion of Upper Bowen Series. Age: Upper Permian.

In the hand specimen this is a fine-grained, homogeneous rock of black colour. It cleaves fairly readily along the bedding, and breaks with a hackly fracture. It has a dull lustre and gives a dull greyish-brown streak. The specific gravity is 1·30. Apparently it is resistant to weathering, as the specimen studied shows no evidence of atmospheric weathering more than three millimetres from the exposed surface. It ignites fairly readily and burns with a bright flame, giving a waxy, aromatic odour. Tiny scales of gypsum arranged in small patches occur at intervals along the bedding planes.

From the above physical properties, adopting Dulhunty's (1943) classification, the hand specimen is identified as a low-grade, dull melanocratic torbanite.

Microscopic.

In thin section the rock shows the uniform microscopic structure characteristic of a torbanite. This consists of translucent gelosite and retinosite bodies, separated by films of opaque matrix. The percentages of these translucent bodies in the rock, determined by means of the eyepiece micrometer, have been found to average 42 % gelosite and 3 % retinosite. This places the rock just over the borderline between a low-grade and a medium-grade torbanite.

As in the Alpha torbanite these translucent bodies are disc-shaped, and appear elongated in the vertical section and roughly rounded in the horizontal section. However, they are much smaller in their average size than those of the Alpha torbanite, the diameter of most of them being only 0·15 mm., and there is also much less variation in their size. They have fuzzy, indefinite margins and, in the horizontal section, present a botryoidal appearance.

Under ordinary transmitted light the gelosite is pale yellow in colour, and the retinosite orange-yellow. They both exhibit the characteristic optical properties as described above for the Alpha torbanite. Both the gelosite and the retinosite bodies also have been replaced to a small extent by chalcedony, but the degree of silicification is less than that in the Alpha torbanite.

The groundmass is made up of humosite and matrosite, and is continuous throughout the rock, surrounding the gelosite and retinosite bodies. It is considerably greater in amount than that of the Alpha torbanite.

Chemical Analysis.

A proximate analysis of this sample has given the following result:—

Moisture at 105 deg. C.	3·0 %
Volatile Matter	45·5 %
Fixed Carbon	20·6 %
Ash	30·9 %

Chemically this indicates a low to medium-grade torbanite. As with all melanocratic torbanites the ratio of volatiles to fixed carbon is less than 10 to 1.

THE NARROWS OIL SHALE.

General and Macroscopic.

Locality of sample chosen for study: From 225 ft. in Munduran No. 1 Bore, The Narrows. Parish of Rundle, county of Deas Thompson, approximately 20 miles N.N.W. of Gladstone. Geological Horizon: The Narrows Tertiaries. Age: Probably Miocene.

In the hand specimen this is a fine-grained, smooth, even-textured rock of pale greyish-brown colour. It is distinctly laminated, the laminations being quite finely developed. It has a dull lustre and breaks with a hackly fracture. It is soft but moderately tough, and gives a greasy pale brown streak. The specific gravity is 1·56. Thin flakes of the rock ignite with some difficulty when heated with a match and burn with a smoky yellow flame.

From the above description it is apparent that the rock is a low-grade oil shale.

Microscopic.

(Plate XII, figs. 3, 4.)

Horizontal and vertical sections of this rock have shown that it is made up principally of very finely divided clay, together with a smaller amount of organic material. The clay is intimately associated with some of the organic matter and, under ordinary transmitted light, the whole clay matrix shows a strong yellowish stain. Scattered through this matrix are small, irregularly-shaped, organic masses of a dark reddish-brown colour. This material, which may reasonably be classified as semi-opaque attritus derived from the decay of vascular tissue, makes up about 20 % of the rock. These semi-opaque masses are irregular but generally more or less elongate in shape, and range in length from approximately 0·01 mm. to 0·35 mm., their average length being about 0·05 mm. Presumably the translucent humic attrital material has been macerated to various degrees, some forming the jelly which impregnated and stained the clay matrix. An intensive search has failed to reveal any spores or algal bodies in the thin sections of this oil shale. Most of the organic matter then has come from vascular material.

Within the clay matrix numerous small grains of quartz were recognised. They have not been affected by the yellowish stain, and appear clear and white under ordinary transmitted light. Pyrites is relatively abundant in the rock, occurring both as minute crystals scattered through the matrix and also as fairly large crystals aggregates. Its presence indicates that the original organic ooze was a strongly reducing medium, analogous to the fetid sapropels described from certain modern lakes.

In the vertical section the parallel orientation of the organic masses and the inorganic constitutents in the rock is evident.

From the large amount of mineral matter and the small amount of organic matter seen to be present it is clear that the oil shale is a low-grade one.

Chemical Analysis.

A proximate analysis of this sample has given the following result:—

Moisture at 105 deg. C.	4·8 %
Volatile Matter	29·1 %
Fixed Carbon	3·3 %
Ash	62·8 %

Chemically this indicates a low-grade oil shale. The low percentage of volatiles is determined by the small amount of organic matter present, while the high ash content reflects the large amount of mineral matter in the oil shale.

STRATHPINE OIL SHALE.

General and Macroscopic.

Locality of sample chosen for study: From 70 ft. in Neill's Shaft, Strathpine. Portion 256, parish of Warner, county of Stanley, approximately 14 miles north of Brisbane. Geological Horizon: Petrie Series. Age: Probably Miocene.

In the hand specimen this is a very fine-grained, smooth, even-textured, laminated rock of light brownish-grey colour. It has a dull lustre and breaks with a hackly fracture. It is soft but moderately tough, and gives a greasy brown streak. The specific gravity is 1·53. Thin flakes of the rock ignite with difficulty and burn for a short time with a smoky yellow flame.

From the above description it is apparent that the rock is a low-grade oil shale.

The presence of mud infillings of the internal cavity of fossil sedges protruding upwards across the laminations of the shale points to shallow water conditions of sedimentation.

Microscopic.

In thin section this rock is seen to be made up principally of very finely-divided clay, with a smaller amount of organic material. The clay is intimately associated with some of the organic matter, and under ordinary transmitted

light the whole clay matrix shows a strong brownish-yellow stain. Scattered through this matrix are small, irregularly-shaped, organic masses of a dark brownish-red colour. This material, which may reasonably be classified as semi-opaque attritus derived from the decay of vascular tissue, makes up from 10 to 15 % of the rock. Some of these organic particles have been found to show good cell structure, particularly in the horizontal section. They vary considerably in size, being never more than 0·4 mm. in length and usually much less. These vascular fragments in the rock are, in fact, in various stages of maceration, and some of them are very nearly opaque. As well as this material a few small, pale yellow, translucent bodies, similar in all respects to the gelosite bodies of torbanite, have been recognised. They appear elongate in the vertical section and roughly rounded in the horizontal one, but they are much more widely spaced than in any torbanite. As gelosite bodies are known to be the fossil form of a colonial, unicellular alga, it is apparent that this oil shale is partly of algal origin. Most of the organic matter in the thin sections, however, is translucent humic matter and brown-opaque attritus. No animal remains were recognised in the thin sections.

A few small grains of quartz and flakes of mica were seen within the clay matrix. They have not been affected by the yellow organic stain and appear clear and white under ordinary transmitted light. Pyrites is quite abundant in the rock, occurring both as very minute crystals scattered through the matrix and also as fairly large aggregates.

In the vertical section the parallel orientation of the organic bodies and the inorganic constituents can clearly be seen.

From the very large amount of mineral matter, and the small amount of organic matter seen to be present, it is apparent that the rock is a low-grade oil shale.

Chemical Analysis.

A proximate analysis of this sample has given the following result:—

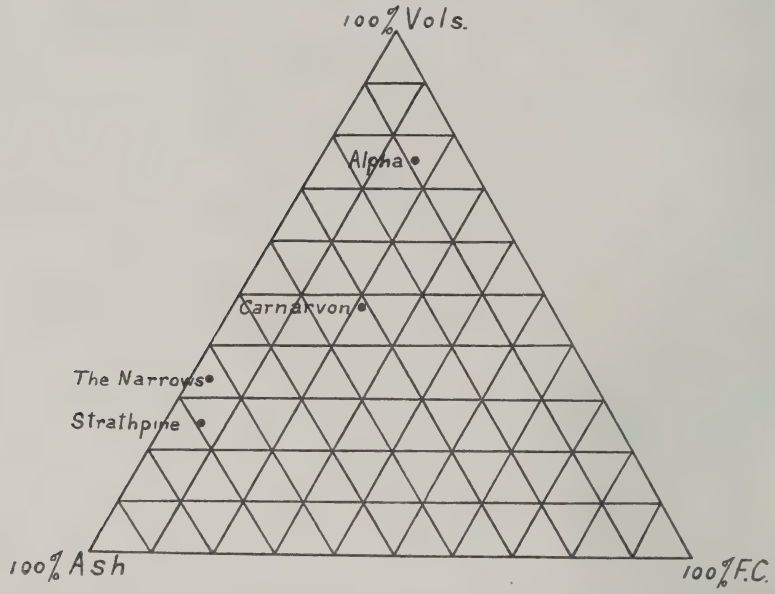
Moisture	6·3 %
Volatile Matter	20·2 %
Fixed Carbon	5·2 %
Ash	68·3 %

Chemically this indicates a low-grade oil shale, which agrees with the determination obtained from the petrological examination of the rock.

CONCLUSION.

From the above descriptions it is clear that the Alpha and the Carnarvon Creek torbanites are very distinct petrologically from The Narrows and the Strathpine oil shales. A striking similarity between the two latter oil shales, however, has become evident. They have been found to be almost identical in macroscopic and microscopic appearance, and in their physical properties. The close petrological relationship between them is also reflected in their

proximate analyses, which are graphically shown on the accompanying text figure together with those of the Alpha and Carnarvon Creek torbanites for purposes of comparison. As recent palaeontological work (Beasley, 1945) has shown that The Narrows Tertiaries and the Petrie Series are both probably of Miocene age, it seems likely that these two Tertiary oil shales were formed at the same time, and they may be correlated with some confidence.



Text-figure 2.—Ternary diagram graphically showing the chemical relationship between The Narrows, Strathpine, Carnarvon Creek and Alpha samples studied.

The two torbanites studied have shown themselves to be generally similar to the Permian torbanites of New South Wales, recently described and classified by Dulhunty (1939; 1943). The medium- to high- grade, dull melanocratic torbanite of the Alpha deposit appears to have precise affinities with the Glen Davis torbanite of New South Wales, while the low-grade, dull melanocratic torbanite of the Carnarvon Creek deposit is the same type as that of Mort's Lower Seam in the Megalong Valley, N.S.W.

ACKNOWLEDGEMENTS.

This work has been financed by the Commonwealth Government Grant through the Council for Scientific and Industrial Research to the University of Queensland. I would like to thank Dr. W. H. Bryan for his helpful criticism, and Professor H. C. Richards for his personal interest in enabling me to carry out this work. I am indebted to Mr. H. G. Dunstan of the Government Chemical Laboratory for the chemical analyses.

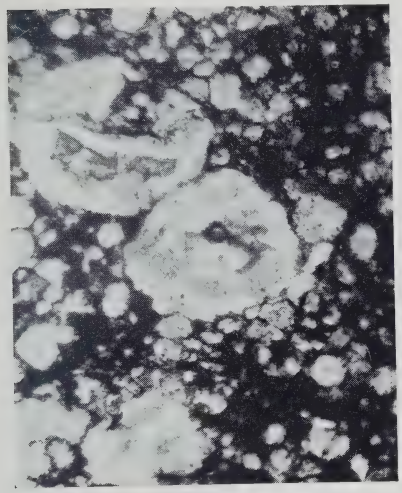


Fig. 1.

Fig. 2.

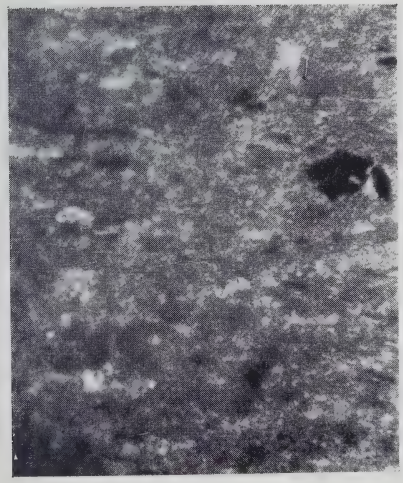


Fig. 3.

Fig. 4.

Queensland Oil Shales.

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EXPLANATION OF PLATE XII.

Fig. 1. *Alpha torbanite. Horizontal section,* 60 diams. Showing closely packed algal colonies consisting mainly of gelosite with some retinosite bodies, set in opaque groundmass of humosite and matrosite. The botryoidal appearance of the compound colonies is well illustrated. Microslide No. 848, University of Queensland Collection.

Fig. 2. *Alpha torbanite. Vertical section,* 60 diams. Showing flattened bodies mainly of gelosite, in opaque matrix. The collapsed central cavities of some of the algal colonies can clearly be seen. Microslide No. 849, University of Queensland Collection.

Fig. 3. *The Narrows oil shale. Horizontal section,* 80 diams. Showing irregularly shaped, semi-opaque vascular fragments in organically stained clay matrix. Microslide No. 850, University of Queensland Collection.

Fig 4. *The Narrows oil shale. Vertical section,* 80 diams. Showing laminated nature of the fine-grained rock. Quartz grains and some of the attrital material can be seen embedded in the clay matrix. Microslide No. 851, University of Queensland Collection.

A NEW CRUSTACEAN.

By Melbourne Ward, F.R.Z.S., F.Z.S.

(Plate XIII.)

Superfamily THALASSINIDEA. Family Callianassidae.

Genus **CTENOCHELES** Kishinouye 1926.

Ctenocheles Kishinouye. Annot. Zool. Japan, xi, I. 63.

Idem, Markarov Faune de L'Urss. Crust., x, 3, 1938, 77, fig. 29.

Type.—*C. balssi* Kish.,

Type locality.—Ohsu, near Kashiwasaki, Niigata-ken, Japan.

"Probably from deep water." de Man.

CTENOCHELES COLLINI sp. nov.

(Plate XIII.)

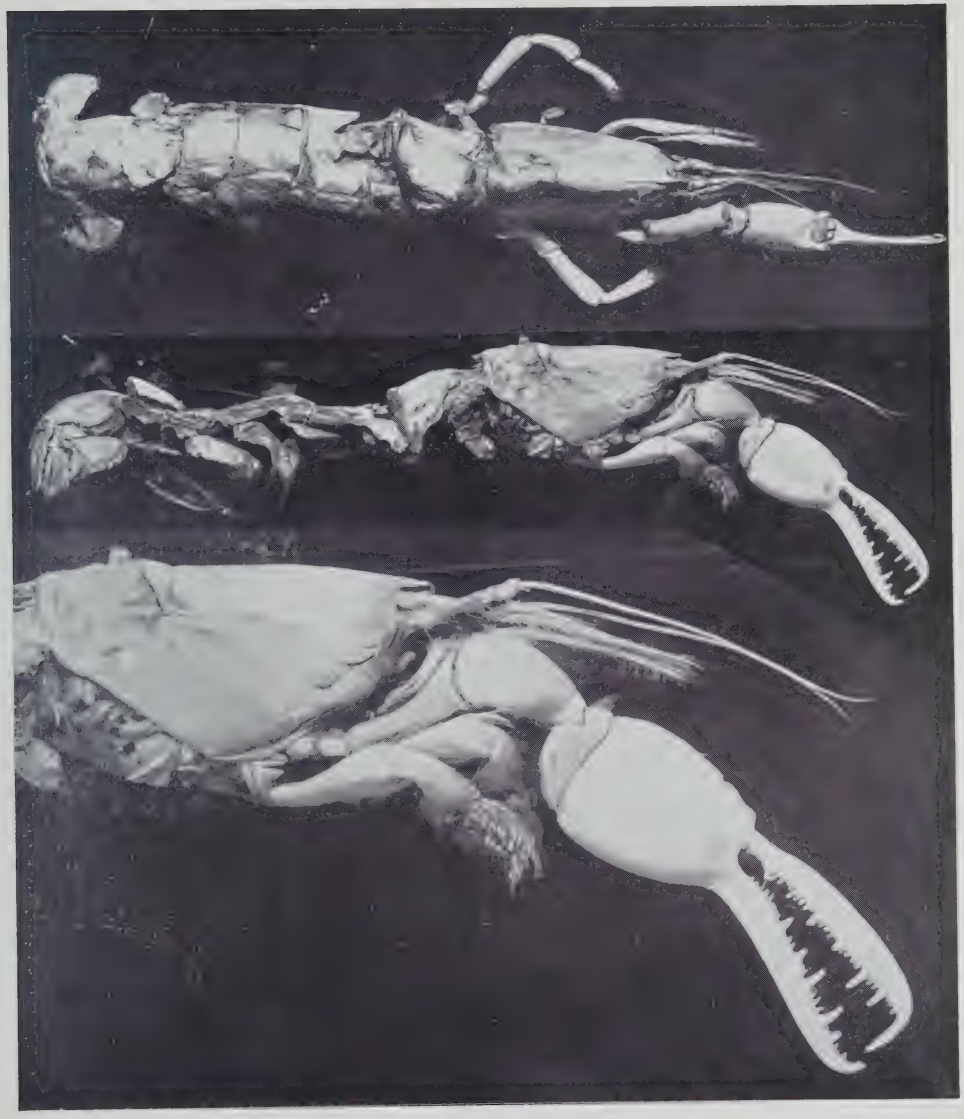
Type locality.—Mud Island, Moreton Bay, Queensland.

This species is related to *C. balssi* and has been named after Mr. V. F. Collin, who collected and presented the specimens to the Queensland Museum. I am indebted to the director for the opportunity of studying the material. Altogether there are three complete specimens and two fragments.

The species is remarkable for the greatly developed cheliped which separates it readily from the other known genera of the Callianassidae on the Australian coast. This character can best be appreciated by an examination of the figure; the left cheliped is greatly reduced is size and differently shaped. In other respects *Ctenocheles collini* is a typical mud-dwelling crustacean, being lightly calcified, therefore soft to the touch, except for the characteristic chelae and anterior portions of the carapace which are hard.

Description of the type.—Length from tip of the rostrum to telson 120 mm. (approximately because of the soft condition of the abdomen). Carapace laterally compressed, the dorsal surface firmly calcified, rostrum developed in a simple spike, thin and entire; the upper margin merging into a well-developed ridge extending almost to the cardiac region. Branchial region soft.

Eyes not pigmented, small flattened, the inner edges of the stalks touching throughout their length, reaching slightly beyond the tip of the rostrum. Antennules more robust than the antennae. Antennae slender, the flagella not twice as long as the antennule. Mouth parts hairy, the third maxillipeds strongly toothed along the opposing edges.



Ctenocheles collini, Melbourne Ward.

Face page 134.

The chelipeds extremely unequal, the larger shaped like the chela of the *Thaumastocheles* of European Seas. The next pair with well developed chelae covered with long yellowish hair. The second walking legs have the propodites flattened and clothed with coarse hair. The third pair are longer and more slender than the first two pairs and the propodite is similarly haired. The fourth pair of legs are the most slender and with only a small amount of hair on the distal article.

The abdominal somites are weakly calcified; second to fifth pair of pleopods all alike.

I regret that at the time of writing I am unable to determine the sexes of the material before me.

(Plate XIII.)

Ctenocheles collini.

Upper figure.—Dorsal view of type.

Middle figure.—Lateral view of type.

Lower figure.—Lateral view of cephalothorax and major cheliped, enlarged.

POSTLARVAL STAGES OF AUSTRALIAN FISHES.—NO. 1. [4]

By Ian S. R. Munro, M.Sc.

(Council for Scientific and Industrial Research).

(Text-figures 1-8.)

It has been the good fortune of the writer to obtain, whilst netting in the estuaries of southern Queensland and New South Wales, many interesting larval and postlarval stages of fishes. In most instances these very young stages differ considerably from the adults of the same species both in proportions and coloration. They present more than the usual difficulties in their specific identification. Descriptions of juvenile stages of even the commoner Australian fishes have never featured to any extent in ichthyological publications. It is the object of this series of articles to outline the principal characteristics of hitherto undescribed early developmental stages of many of our commercial and better known species.

As most of the postlarvae featuring in the following descriptions are less than twenty millimetres in length, special gear had to be employed for collecting. Plankton tow nets were useful for the capture of the smaller pelagic larvae and postlarvae. The bulk of the collecting was carried out by means of a special small meshed hauling seine net designed by the writer for the specific task of capturing fish fry sheltering in *Zostera* weed beds of shallow creeks and mud flats, and in the sandy shallows near river mouths. This net was shot by wading it around at low tide. Its length was 25 yards and the depth four feet. The bunt was of 7 millimetre square meshed French netting with an innermost section and pocket of 4 millimetre square mesh. The wing sections, each of 10 yards, were of $\frac{7}{8}$ inch prawn netting. This type of net was found to be most successful for this particular purpose.

Acknowledgment is due to Mr. G. L. Kesteven, who made available a quantity of unsorted plankton from the Noosa River collected in June 1940. This is supplementary to the writer's own extensive monthly plankton collections during the years 1944 and 1945.

1. ACANTHOPAGRUS AUSTRALIS (Günther). AUSTRALIAN BREAM.

Chrysophrys australis Günther (1859), p. 494.

A detailed description of the eggs and early larvae of the Australian Bream has already been published by Tosh (1903). Kesteven and Serventy (1941) have shown that this species spawns near the mouths of southern Queensland rivers. It may be added that the main spawning begins with the Sea Bream runs of May and June but sometimes occurs earlier and appears to continue throughout the winter months. The eggs are pelagic and are spawned at night on a flooding tide when the moon is full. The larvae are planktonic

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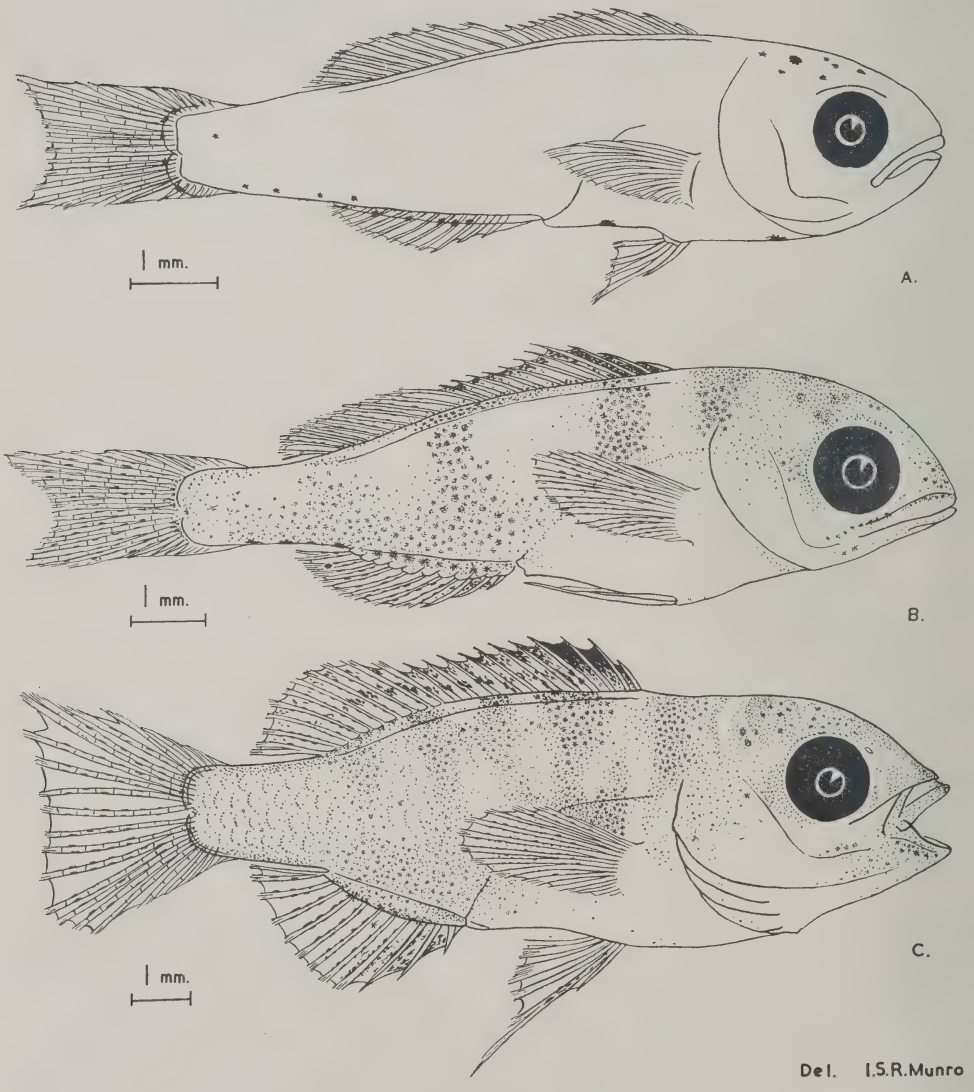
[4] Contribution No. 41 from the Marine Biological Laboratory, C.S.I.R., Division of Fisheries, Cronulla, New South Wales.

until they attain a length of approximately 12 millimetres. Such larvae have been collected in tow nets in the Noosa River during March 1944 and June 1940 and in Bribie Passage (Caloundra) during March 1944. It has been observed in both these estuaries that, upon reaching this size, these Bream fry leave the plankton and congregate, along with those of the related *Austrosparus sarba* and other species, amongst the *Zostera* weed growth of shallow flats and brackish creeks within a mile or so of the respective river mouths. Similar nursery grounds have been observed near the mouths of the Bellinger River, Nambucca River and Lake Macquarie. This change of habitat coincides with the first indication of development of sub-adult pigmentation.

Bream larvae and postlarvae smaller than 12 millimetres are wholly transparent and are characteristically marked with distinctive series of black chromatophores. There is probably some yellowish pigment, but this has not been observed in the formalin preserved specimens used in the present study. In a typical planktonic postlarva of length 10·5 millimetres as is illustrated in text fig. 1A, the black chromatophores form three series, namely: a cluster on the postero-dorsal aspect of the head; a longitudinal series following the ventral margin of the caudal somites, mainly at the bases of the anal and caudal fins; an internal cluster lining the visceral cavity postero-dorsally. In postlarvae of this size, the head length is approximately 4 and the greatest body height 4½ in the total body length. The eye diameter is slightly greater than the snout length and is 3 in the head length.

The smallest Bream collected in the seine net measured 12·5 millimetres and is illustrated in text fig. 1B. Its pigmentation indicates the beginning of the transition from planktonic to littoral habitat. The sparse black pigmentation characteristic of planktonic facies is being masked by a proliferation of chromatophores constituting the rudiments of a pattern of light and dark banding which is destined to persist throughout the first year of life. The nature of this change is parallel to that shown to take place in various Mediterranean species of Sparidae by Ranzi (1933) and in the American Scup by Kuntz and Radcliffe (1917). Bream postlarvae of 12 millimetres and over show a progressive development of blackish brown V-shaped vertical bands on the dorsal half of the body, superimposed upon a general ground coloration of greenish bronze. About six or eight of these bands appear and they are alternately broad and narrow. Small Bream differ from small Tarwhine (*A. sarba*) in the pattern of banding, the latter species possessing five or six approximately equal and broader bands which extend ventrally below the level of the mid-line. The cephalic series of black chromatophores of the planktonic postlarvae are substituted by paired clusters overlying the hind brain on the postero-dorsal region of the head. These are characteristic in that they are relatively less distinct than those of the Tarwhine. At 16·0 millimetres the first rudiments of scales are noticeable, each scale being outlined on its ctenoid margin by a semi-circle of pigment dots. These are noticeable in the caudal region of the specimen depicted in text fig. 1C. At 18·0 millimetres a complete coat of scales is discernible. At this stage of development the lateral line is marked off by its relatively darker pigmentation. Increase of brownish pigment on the scales gives the appearance of a parallel series of longitudinal brownish

stripes both above and below the lateral line, in postlarvae a trifle larger. These extend ventrally to the level of the mid-line and are part of the adult pigmentation. The intensely black margin of the spinous dorsal fin and of its membrane in the region of the first few spines serves further to distinguish young Bream from those of Tarwhine, which have a much lighter pigmentation on the dorsal fin membrane.



Text-fig. 1.—Post-larvae of Australian Bream, *Acanthopagrus australis* (Günther).
A.—From a specimen 10.5 mm. long.
B.—From a specimen 12.5 mm. long.
C.—From a specimen 16.1 mm. long.

At a length of 12 to 16 millimetres the body depth has increased in proportion and is approximately equal to the head length, which is $3\frac{1}{2}$ to $3\frac{2}{3}$ in the total length. In adults the head length decreases to about $4\frac{1}{2}$ and the body height increases to $2\frac{2}{3}$ in the total length. The eye diameter decreases from 3 to $3\frac{1}{4}$ in the head length during growth from 12 to 16 millimetres.

Specific diagnosis was arrived at by following through changes in proportions and pigmentation in a very complete series of many score of specimens of intermediate sizes ranging from planktonic larvae to adults. Possession of the average fin formula of D. XII, 11; A. III, 8-9 separates these young from those of *A. sarba*.

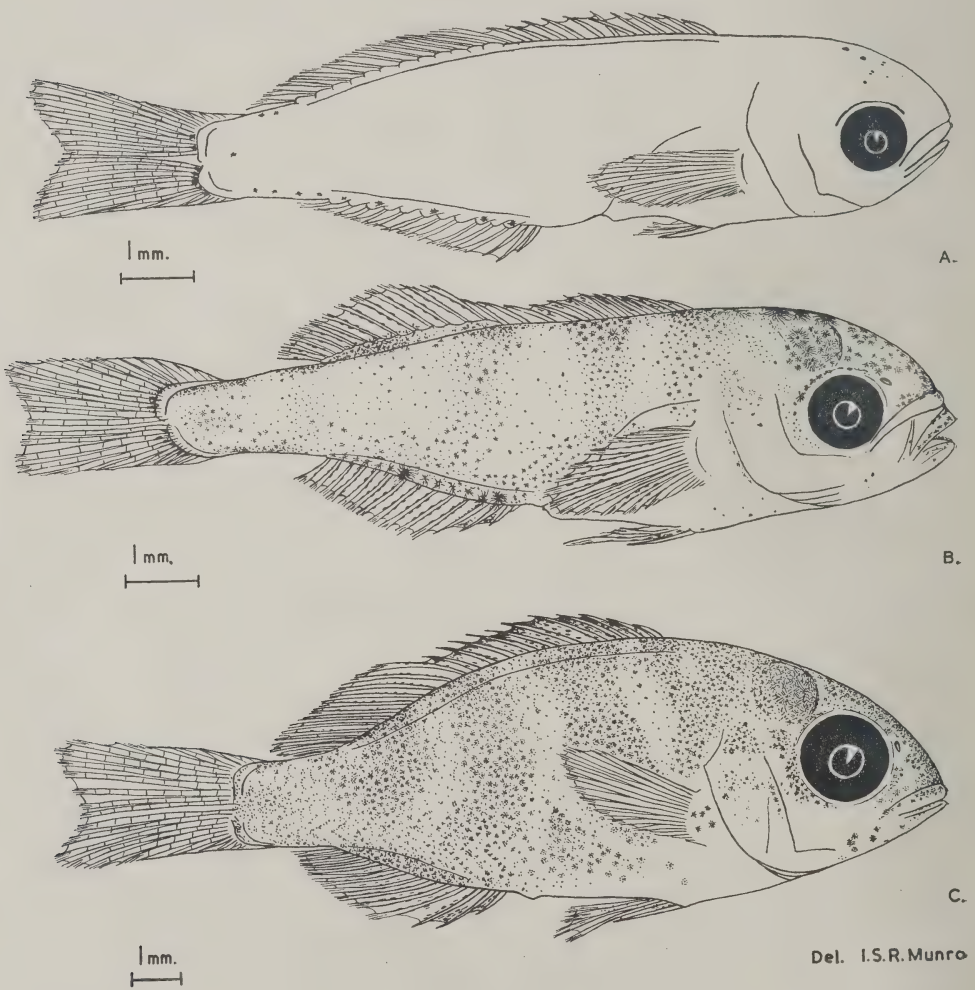
2. AUSTROSPARUS SARBA (Forskål). TARWHINE.

Sparus sarba Forskål (1775), p. 31.

Review of the literature dealing with the Tarwhine, *Austrosparus sarba* (Forskal) reveals that little direct observation has been made in respect to its spawning season. Roughley (1916) indicates that it occurs during early summer. The eggs and larvae are entirely unknown. The writer has noticed that postlarvae, identifiable by their fin counts as being this species, occurred simultaneously with those of the Bream (*A. australis*) in the Noosa River plankton during June 1940. Also, larger postlarvae occur simultaneously with those of *A. australis* in the weedy shallows and creeks near the mouths of Noosa River, Bribie Passage and other east coast estuaries. This evidence rather suggests that both these Sparid species spawn during the same extended season, which in southern Queensland during 1944 was the winter months.

Several postlarvae, varying in size from 11·0 to 12·4 millimetres, have been obtained in the Noosa River plankton in June 1940, and another specimen 11·5 millimetres long was taken in a surface plankton haul at Caloundra on 12/11/44. The smallest postlarval Tarwhine collected with the seine net also measured 11·5 millimetres and was taken in shallow water in the creek joining Weyba Lagoon to Noosa River on 25/6/44. All of these postlarvae have the typical planktonic facies indicated in text fig. 2A. At this stage of development they closely resemble in appearance postlarval *A. australis* of similar size. Their distinctive fin formula, namely D. XII, 13; A. III, 11 which is two or three rays greater in both soft dorsal and anal fin counts than *A. australis,* is the most reliable clue to their diagnosis. These postlarvae are quite transparent and their black pigment is arranged similarly to that of *A. australis* at the same stage of development. The ventral linear series that extends from the anus to the base of the caudal fin is practically identical. The chromatophores of the head are smaller in size and fewer in number and do not extend as far back behind the eye as those of Bream. There is an internal lining of dark cells on the dorsal surface of the visceral cavity and an internal longitudinal series situated dorsally to the vertebral column and extending from the perpendicular at the anus backwards to the base of the tail. The head is shorter than that of the Bream, being $4\frac{1}{4}$ to $4\frac{1}{2}$, and the greatest body height $4\frac{3}{4}$ in the total length. The eye diameter is similarly about 3 in the head length, but the perpendicular measurement between the upper margin of the eye and the top of the head is much greater in *A. sarba* at this stage.

As soon as the postlarval Tarwhine leave the plankton (11·5 to 12·5 millimetres) and frequent the weedy shallows and creeks near the mouths of rivers, their pigment begins to change in pattern and coloration more adapted to the new surroundings. As in *A. australis* and other Sparidae of which the postlarvae are known, this change consists in the development of vertical light and dark banding. Like *A. australis* the ground colour is a greenish bronze and the superimposed banding is blackish. There are five or six equally broad bars interspaced with lighter areas of approximately similar width. These bands are broader and straighter than those of the Bream and extend downwards across the flanks fading away near the ventral margins. Two stages illustrating



Text-fig. 2.—Post-larvae of Tarwhine, *Austrosparus sarba* (Forskal).
A.—From a specimen 12.4 mm. long.
B.—From a specimen 12.8 mm. long.
C.—From a specimen 17.8 mm. long.

the progressive development of this pattern are shown in text figs. 2B and 2C. There is a rapid early change in the head pigment. The chromatophores overlying the brain greatly increase in size and number and form intensely dark rounded patches, one on either side of the head behind the eyes. These are more obvious than in *A. australis.* The spinous dorsal fin membrane receives some black pigment when a size of about 18·0 millimetres is attained but is not so intense as in the Bream. Also at this stage of development scales are apparent. The lateral line is discernible at 20·0 millimetres. During the subsequent ten millimetres growth the rows of scales become visible macroscopically, outlined as longitudinal parallel bands of a brownish colour. These develop into the characteristic longitudinal golden bands of adults, there being six or seven above the lateral line and considerably more below it. Postlarval Tarwhine less than 18·0 millimetres in length have been collected at Caloundra as early as June and in the Noosa River as late as October.

Text fig. 2 indicates how the body proportions alter greatly early in postlarval life. At a size of 18·0 millimetres the body height has exceeded the head length, which has increased to 3½ in the total length. The eye remains conspicuously large. At a length of 30·0 millimetres the steepness of the snout is most noticeable when the head is viewed in profile.

A comprehensive series of stages constituting a complete range of intermediate sizes from planktonic postlarvae to adults form the basis of this description.

3. PELATES SEXLINEATUS (Quoy & Gaimard). TRUMPETER PERCH.

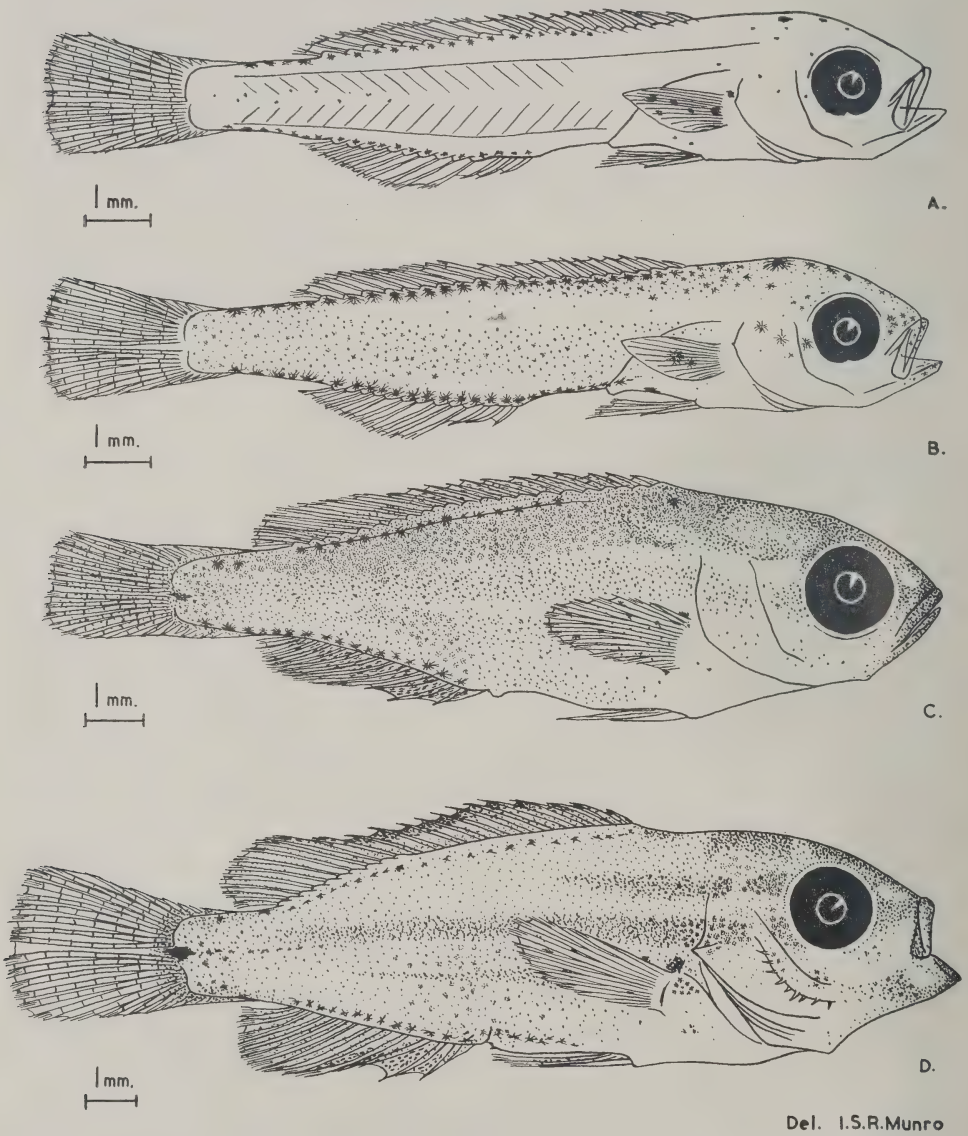
Pristipoma sexlineatus Quoy & Gaimard (1824), p. 320.

Pelates quadrilineatus Cuvier & Valenciennes (1829), p. 146, pl. lv.

A third type of planktonic postlarva with facies generally resembling those of postlarval *A. australis* and *A. sarba* has been collected in tow nets, both in the Noosa River and Bribie Passage estuaries. Two specimens (8·4 mm.) were obtained in March 1944 near the Bribie Passage (Caloundra) entrance and a further four specimens (5·5, 10·5, 11·0 mm.) in the Noosa River during the following month. Others (12·9 to 13·6 mm.) were obtained in the same locality during June 1940. Another (13·5 mm.) was collected in the Noosa River plankton as late as October in 1944 and on the previous day (13/10/44) three other individuals (11·2 to 12·6 mm.) were caught in a dip net at Tewantin township, several miles upstream. The latter were amongst a school of small postlarval *Ambassis jacksoniensis* which were working in close to the bank.

These postlarvae have been identified as those of the common little Trumpeter Perch, *Pelates sexlineatus* (Q. & G.) which is invariably present during most months of the year amongst weed growing in the shallows of most east coast estuaries. The October planktonic postlarvae illustrated in text fig. 3B (13·5 mm.), by virtue of its possession of an intermediate pigment pattern, links up between the younger planktonic postlarva (text fig. 3A) and the tiny recognisable juveniles of this species that frequent the *Zostera* beds in sheltered places. The fin formula D. XII, 10; A. III, 10; P. 15, characteristic of this species and possessed by these planktonic postlarvae gives the necessary confirmation to the diagnosis.

The spawning habits and the characteristics of the eggs and early larvae of *P. sexlineatus* are unknown, except what can be deduced from the above collection data, namely that the spawning season is an extended one, presumably beginning in late summer and lasting until well into the winter. As the localities of collection of postlarval *P. sexlineatus* are the same as those of



Text-fig. 3.—Post-larvae of Trumpeter Perch, *Pelates sexlineatus* (Quoy & Gaimard).
A. and B.—From specimens 13.5 mm. long.
C.—From a specimen 15.0 mm. long.
D.—From a specimen 18.5 mm. long.

other species of which the spawning habit is known, e.g. *Acanthopagrus australis* and *Ambassis jacksoniensis*, it might be deduced that the spawning grounds are the same as for these species, namely close to river mouths. The eggs are probably pelagic.

Planktonic postlarvae are quite transparent and have two prominent series of black chromatophores. One of these is a dorsal series along the bases of the dorsal fins extending back to the caudal peduncle. The other series is ventral and extends from the base of the first anal fin-spine to the caudal peduncle. There are a few scattered cells on the head and an internal cluster lining the visceral cavity. The visceral mass is also heavily pigmented with other colours which fade when preserved in formalin. The body is rather slimmer than that of the Sparidae described above and the head is likewise not as deep and the snout more pointed. The head length is about 4 and the greatest body height 6 in the total length. The eye is approximately 3 in the head length and still possesses a slight ventral depression which is the choroid fissure.

It appears that postlarval *P. sexlineatus* leave the plankton when growth to a length of approximately 13·0 or 14·0 millimetres has been attained. They then begin to frequent the sheltered weedy shallows along with the fry of several other common estuarine species.

As in the Sparidae there are similar adaptive changes in body pigmentation coinciding with the adoption of a littoral habit. In *P. sexlineatus* this is a longitudinal brownish banding on a greenish ground colour. Text figs. 3B to 3D show this change of pigmentation on individuals possessing respective lengths of 13·5, 15·0 and 18·8 millimetres. The older postlarvae shown in text figs. 3C and 3D were both collected in June when using the seine net in a shallow creek at the north end of Bribie Island. The longitudinal bands which increase eventually to six in number are first developed more distinctly on the head and anterior trunk regions. The series of black cells characteristic of the planktonic stages persist temporarily as a secondary pigmentation but disappear at a length of 25·0 to 30·0 millimetres. These chromatophores are greatly enlarged and spider-like in form. There is a single chromatophore of this type at the base of each dorsal and anal fin-spine and fin-ray and others on the caudal peduncle and on the ventral margin of the gut region. This series is most noticeable in the planktonic stage shown in text fig. 3B but the chromatophores decrease in relative dimensions as the fish grows larger. A large black irregularly shaped spot located centrally at the base of the caudal fin is a prominent feature of all immature trumpeters. It is noticeable first at about 15·0 millimetres. Postlarvae of this size also have some development of dark pigment cells on the membranes of the dorsal and anal fins. The head length in juveniles of 15·0 to 19·0 millimetres has increased to about $3\frac{2}{3}$ or $3\frac{1}{2}$ in the total length and the body height has increased similarly to approximately the same proportion. The first indication of the presence of scales is to be noticed in postlarvae 18·5 millimetres long, especially along the lateral banding where the margin of each scale is outlined by a tiny semi-circle of blackish pigment cells. The preopercular spines are also evident in postlarval *P. sexlineatus* of this size.

4. GIRELLA TRICUSPIDATA (Quoy & Gaimard). **BLACKFISH.**

Box tricuspidatus Quoy & Gaimard (1824), p. 296.

Blackfish, *Girella tricuspidata* (Q. & G.) as small as two inches long are to be found commonly in most estuaries of the east Australian coast, when netting amongst weed. Interest lies in the fact that smaller postlarvae of this species can easily be mistaken macroscopically for the young of our Sparidae, particularly Bream. Two small specimens, measuring respectively 15·0 and 17·6 millimetres were obtained in the seine net in the Nambucca River on 19/10/44. The larger of these is illustrated in text fig. 4. In general shape it superficially resembles postlarval *Acanthopagrus australis* of similar size (compare text fig. 1C). It can be distinguished at once by a distinctive fin formula which is usually D. XV, 12; A. III, 12 but in the specimen figured

Text-fig. 4.—Post-larval Blackfish, *Girella tricuspidata* (Quoy & Gaimard). From a specimen 17.6 mm. long.

is D. XIV, 13; A. III, 12. The colour is brownish olivaceous and there are about seven darker vertical bands on the back. There is a secondary series of jet black chromatophores which apparently persist from planktonic stages. There is one linear series of these along the bases of the dorsal fin-rays and fin-spines, and another less distinct ventral series along the bases of the anal fin-rays. There are a few such cells on the head and operculum and a very prominent large cluster on the visceral region directly behind the origin of the pectoral fin and largely hidden by it. A very prominent linear series extends from the centre of the base of the caudal fin, along the mid-line of each side of the body, to the posterior margin of the pectoral fin. The head length and body height are approximately equal and both slightly less than 4 in the body length. The eye diameter is approximately $2\frac{2}{3}$ in the head length.

5. SILLAGO CILIATA Cuvier & Valenciennes. **SAND WHITING.**

Sillago ciliata Cuvier & Valenciennes (1829), p. 415.

Tosh (1902) has already described in detail the eggs and early larvae of the common Sand Whiting, *S. ciliata* Cuv. & Val. which he refers to in his account as *S. bassensis* Cuv. & Val. His material includes no larval stages greater in size than 2·5 millimetres. Tow nettings in the Noosa River during

1944 have produced planktonic stages comparable in development to those described by Tosh. In addition, this source yielded many postlarvae intermediate in size and development between these and the smallest fry that have been seine netted in the sandy shallows of the same estuary. A selected series of such stages is depicted in text fig. 5 and is of particular interest in exhibiting development of the fin-rays and the transition of pigmentation from the simple larval pattern to the dorsal blotching, characteristic of the younger age-groups of this species.

According to Tosh (1902) the spawning season in Moreton Bay (Southport) is September to February. Larvae and postlarvae ranging in size from 1·5 to 8·0 millimetres and recognisable as those of *S. ciliata* appeared in the Noosa River plankton first in September. Slightly larger planktonic postlarvae (11·0 mm.) were taken in October and again in December. The smallest Sand Whiting caught in the seine net measured 15·5 millimetres. Postlarvae of sizes less than 20·0 millimetres have been seined at Caloundra and Noosa River in June, September, October, November and January. Fry measuring 30·0 millimetres have been collected similarly from April onwards. Apparently the spawning period is an extended one, but the planktonic phase appears to be restricted mainly to early summer and for each individual it terminates when a size of about 15·5 millimetres has been reached.

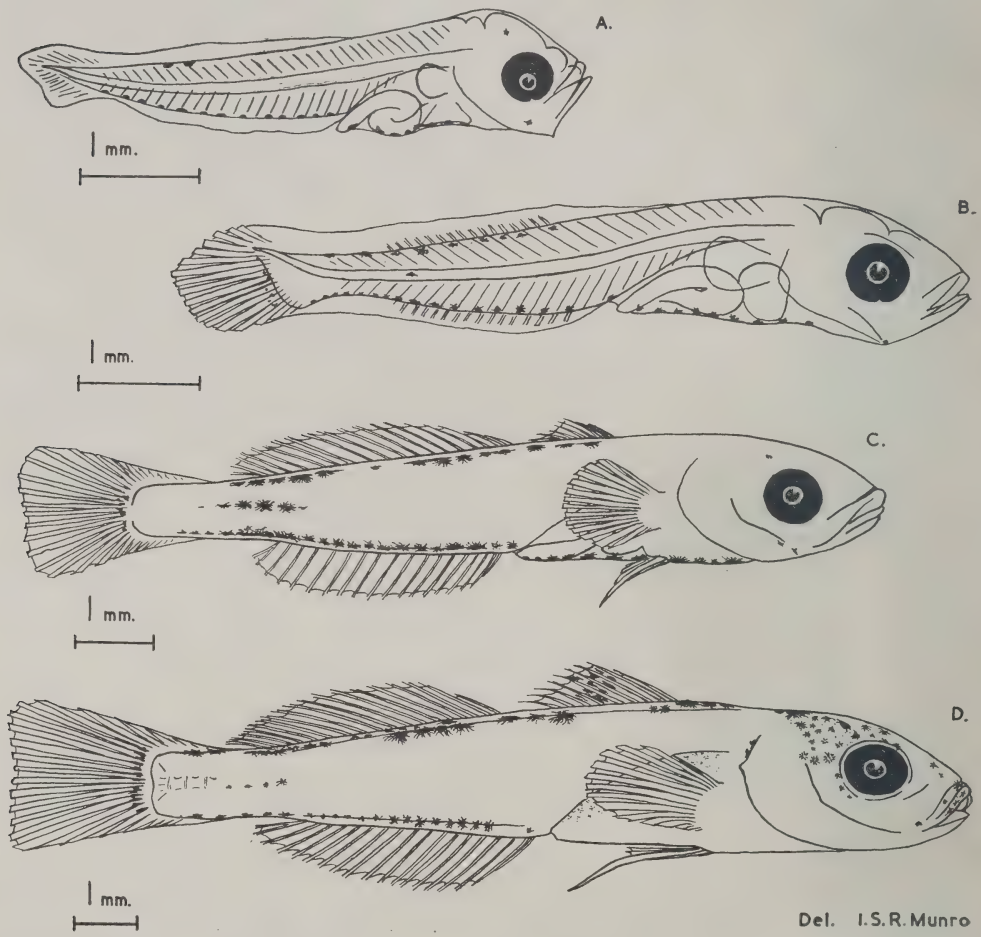
Planktonic larvae less than 5·0 millimetres in size (text fig. 5A), although possessing a well-developed mouth and with complete absorption of the yolk material, have yet to differentiate their fin rays. The black pigment is arranged in a single ventral series extending from the region of the heart posteriorly to the tail region. There are usually about eight cells anterior to the anus and rather less chromatophores than caudal myotomes in the post-anal region. There are one or two isolated cells on the dorsal border of the caudal region.

In larvae of 6·5 millimetres (text fig. 5B) the rudiments of the rays of the dorsal, anal and caudal fins are well differentiated. The black chromatophores of the ventral series persist from earlier stages but the dorsal series has increased in number and extends further forward basally along the second dorsal fin.

At 10·5 millimetres (text fig. 5C) all fins and their radial components are well defined. The number of rays are easily counted, making it possible to identify these larvae specifically as *S. ciliata* rather than *S. maculata*. They possess the characteristic modal fin formula: D. XI. I, 17; A. I, 18; P. 15. The black chromatophores are greatly enlarged and stellate. The ventral series still persists along the gut and extends past the anus along the ventral border of the caudal somites. There is a large chromatophore at the base of each anal fin-ray. The dorsal series is restricted to the areas at the bases of the fins and the chromatophores have increased in number and are arranged in groups. A third series has made its appearance along the mid-line of each side of the body. These post-larvae are still planktonic.

Upon reaching a size of 15·5 millimetres (text fig. 5D), namely the stage when the habit is altered from planktonic to littoral, the tiny Sand Whiting begins to acquire the shape and general facies of the adults of its species and

is readily recognisable as such. The ventral chromatophore series is now restricted to the base of the anal fin. The dorsal series extends further forward than previously and is grouped in several clusters. Small stellate cells covering the brain are visible through the transparent dorsal surface of the head above



Text-fig. 5.—Larvae and Post-larvae of Sand Whiting, *Sillago ciliata* Cuv. & Val.
A.—From a specimen 5.0 mm. long.
B.—From a specimen 6.5 mm. long.
C.—From a specimen 10.8 mm. long.
D.—From a specimen 15.5 mm. long.

the eyes. Similar cells lining the visceral cavity can also be seen through the body tissues and there are several sub-surface groups along the mid-line of each side of the body. Additional surface cells can now be seen at the base of the caudal fin and on the head, particularly around the lips. Rows of black ovate cells which are the rudiments of the oblique banding across the spinous dorsal

fin have appeared on the membrane of that fin. The elongate, bifurcid first soft ray of the ventral paired fins is a noticeable character of postlarvae of this size and larger.

Postlarvae, when leaving the plankton, have body proportions somewhat similar to adults, namely with head length 4 in the total length and the greatest body height $\frac{2}{3}$ that of the head length. The head length to body height proportion varies little with increase in age, but the head length increases to about $3\frac{1}{2}$ in the total length by the time maturity is reached.

At Caloundra and Noosa River this species is to be found during all months of the year; individuals smaller than 90 millimetres abounding in small schools in the shallows, mainly over sand. All characteristically possess dark markings on the dorsal half of the body. In fry of 15·0 to 20·0 millimetres there are two rows of about eight rounded clusters of brownish black chromatophores forming blotches, one series along the dorsal margin and the other along the mid-line of each side. At 30·0 millimetres these have fused and form irregular bands on the upper half of the body, each pointing obliquely downwards and forwards. According to Ogilby (1893) these markings are characteristic of the young of both *S. ciliata* and *S. maculata,* but persist in the adult stages of the latter species only. The black spot at the base of the pectoral fin is not developed until late in the first year of life.

6. ICHTHYSCOPUS LEBECK (Bl. & Schn.). **QUFENSLAND STARGAZER.**

Uranoscopus le Beck Bloch and Schneider (1801), p. 47.

Uranoscopus inermis Cuvier and Valenciennes (1829), p. 310, pl. lxvi.

Adults of this extraordinary species have always been objects of special interest because of their unusual shape and habit. The present note concerns a single postlarval specimen of 15·4 millimetres length. This was captured in the fine meshed seine net in the sandy shallows near the mouth of the Noosa River on the 13th of October, 1944. This postlarva is sufficiently advanced in development to be readily identified as the common Stargazer of the Queensland coast, known to authors as *Ichthyscopus lebeck* (Bl. & Schn.). Although Whitley (1936) has proposed the specific name *sannio* for this Australian form, the present writer has found insufficient justification for this separation after comparing the adult specimens in the Queensland Museum collection with the descriptions of Indian material by Cuvier and Valenciennes (1829) and Day (1876).

This postlarva, illustrated in text fig. 6, differs somewhat from adults of the species both in proportions and coloration. The fin formula is D. ?, 18; A. 17; P. 17; V. I, 5, which agrees closely with those of adult specimens in the Queensland Museum collection. The eye diameter is relatively large as compared with the head length and the eyes are placed dorso-ventrally instead of dorsally as in adults. The migration of the eyes, from a lateral position in larvae to the dorsal aspect of the head of adults, by disproportionate growth of the skull bones has been observed also in related forms, namely the American *Astroscopus guttatus* by Pearson (1941) and the Mediterranean *Uranoscopus scaber* by Salfi (1933). The mouth with its characteristic labial fringes has already become vertical. The exposed bony cheek plates are discernible as their

respective developing components but differ somewhat in shape from those of adults. The cleithrum bones are, at this stage, bluntly rounded, massive processes on the posterior of the skull. They lack the sharp, internal, bony, spinous projection and its surrounding, fleshy, ventrally fringed, humeral flap

Text-fig. 6. Post-larva of the Stargazer, *Ichthyscopus lebeck* (Bl. & Schn.). From a specimen 15.4 mm. long.

which is a noticeable and unusual structure located above the pectoral fins of adult *Ichthyscopus*. The pectoral fin is relatively larger in postlarvae than in adults.

The pigmentation is totally unlike that of adults. The postlarval body completely lacks the canary yellow ground coloration with its superimposed chocolate brown, reticulate pattern on the dorsal part of the back, and the finer mottling on the head. Posterior to the line joining the origins of the second dorsal and anal fins, the body is quite immaculate as are likewise the soft dorsal, anal and caudal fins. During life, this portion of the body is quite transparent and contrasts with the blackness of the head and the dark band of pigment which surrounds the body in the region between the head and the origins of the soft dorsal and anal fins. The pectoral fin is also darkly pigmented on the rays and membranes, particularly on the basal half. The ventral paired fins are only lightly pigmented. The head pigment is composed mainly of largish stellate cells which are in greatest concentration on the preopercular and subocular regions. The latter is particularly prominent and persists as a large, rounded, dark blotch below the eyes of adult Stargazers. The dark parts of this postlarva had a metallic iridescent sheen when viewed macroscopically in the living condition.

7. SPHFROIDES HAMILTONI (Richardson). COMMON TOADFISH.

Tetrodon hamiltoni Richardson (1846), p. 63, pl. xxxix, f. 10-11.

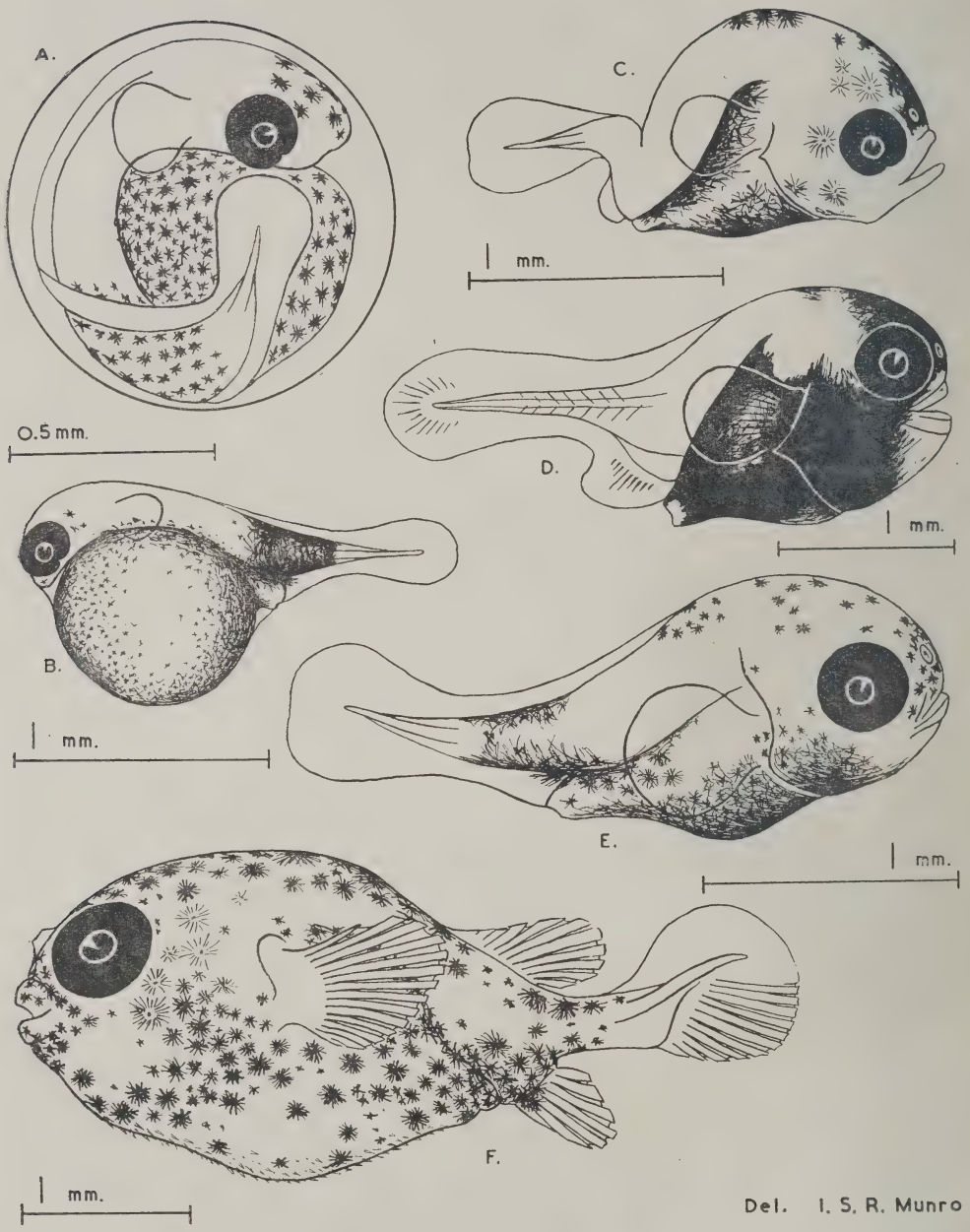
A few larval and postlarval stages, recognisable as belonging to fishes of the Family Tetraodontidae, have been picked up in surface tow nettings near the mouth of the Noosa River, some in June 1940 and others during April, August and September 1944. A few eggs, collected in the same locality in April, had a greyish, rough, thickened outer coating and led the writer to suspect that they were demersal rather than pelagic and had been brought to

the surface by the rip of the ebbing tide. Welsh and Breder (1922) have shown that the related American *S. maculatus* has adherent demersal eggs. The Noosa River eggs measured 0·94 millimetres in diameter and from them hatched larval toadfish which have been identified as our common species *S. hamiltoni.* At first there is a globular yolk-mass underneath the highly pigmented skin of that region which soon becomes the visceral region. The yolk is soon absorbed, and upon attaining a size of 2·0 millimetres a close resemblance to adult facies becomes apparent.

Two distinct types of toadfish larvae have been collected in tow nets and adults of two species, namely *S. hamiltoni* and *S. pleurogramma,* commonly frequent southern Queensland estuaries. These larvae possess complete opercula, which in the adults of this family are reduced to small, rounded apertures situated anteriorly to the pectoral fins. Adult *S. pleurogramma* differs from *S. hamiltoni* in the possession of a prominent spine at the base of the opercular opening. One type of planktonic larva (text figs. 7C and 7D) possess a prominent angular opercular border. The relationship of these larval types to the respective adults is thus evident on the basis of this character alone. The specific identification of these respective larvae was supported further by following through pigmentary changes until a size was reached where adult diagnostic characters were available. There is also correlation between the seasons of occurrence of these respective larval types and the seasons of appearance of small, recognisable postlarvae of both species in the weedy shallows of Noosa River and Bribie Passage. Larvae, identified as those of *S. hamiltoni,* were found in Noosa River plankton collections during April, June, September and October whilst those of *S. pleurogramma* have only been collected in August and September. The former species appears to have a more extended spawning season than the latter.

The larvae of *S. hamiltoni* are approximately 1·6 millimetres in length upon emergence from the egg and are pigmented similarly to the advanced egg-embryo of that species illustrated in text fig. 7A. There is a mass of blackish chromatophores on the frontal region of the head, another mass investing the yolk-sack and a third series forming a lateral patch on either side of the caudal myotomes. The latter group is composed of chromatophores longitudinally arranged in four or five almost parallel rows. There appears to be some slight difference in the pigmentation of the planktonic larvae of this species in respect to the month spawned. Those collected in June 1940 have pigment arranged as above, but when this type have grown to about 2·6 millimetres (text fig. 7E) there is an extension backwards of the head pigment to the level of the origin of the dorsal natatory fold. The scattered, stellate cells of the caudal flanks have become rearranged into dark patches along the dorsal and ventral somite margins, linking across the caudal regions in a diffuse band. The September larvae differ in lacking the caudal pigment completely and there are two patches of dorsal cells, one on the head and the other on the body somites near the origin of the dorsal natatory fold.

A single larger postlarva, 4·6 millimetres in length, was collected in the Noosa River plankton at the surface on the 13th October, 1944. Its pigmentation is composed solely of dispersed, large, stellate, black cells arranged as



Text-fig. 7.—*Spheroides hamiltoni* (Richardson) and *Spheroides pleurogramma* (Regan).

A.—Egg of *S. hamiltoni*, diameter = 0.94 mm.
B.—Newly hatched larva of *S. pleurogramma*, length = 1.7 mm.
C.—Larva of *S. pleurogramma*, length = 2.0 mm.
D.—Advanced larva of *S. pleurogramma*, length = 3.2 mm.
E.—Larva of *S. hamiltoni*, length = 2.6 mm.
F.—Post-larva of *S. hamiltoni*, length = 4.6 mm.

shown in text fig. 7F. At this size the development of the short dermal spines is evident and many can be seen clearly in the belly region. The dorsal, anal and pectoral fin-rays are well defined but all of the caudal rays are not completely differentiated. The fin formula is D. 9; A. 7; P. 15, which is modal for *S. hamiltoni*. The smallest postlarva taken in the seine net measured 8·5 millimetres. It was collected in the creek at the north end of Bribie Island on October 6th., 1944 along with the 10·5 millimetre specimen shown in text fig. 8B. The 8·5 millimetre specimen possessed the ability to inflate itself, as is characteristic of adults of this family. The postlarvae appear to leave the plankton when a length slightly greater than 4·6 millimetres is attained. The larger postlarva shown in text fig. 8B (10·5 mm.) has the body proportions and meristic characters of adult *S. hamiltoni* but its pigmentation is different. The larger, stellate, black chromatophores, that are interspaced with smaller ones on the dorsal surface, apparently represent the rudiments of the adult mottling of large round spots with minute specks in the interstices. The dark lateral stripe, composed of closely packed black chromatophores, presumably represents the rudiment of the series of discontinuous, oval blotches which ornament the flanks of adult toadfish.

8. SPHEROIDES PLEUROGRAMMA (Regan). **GOLD-BANDED TOADFISH.**
Tetrodon pleurogramma Regan (1903), p. 300, pl. xxiv, f. 2.

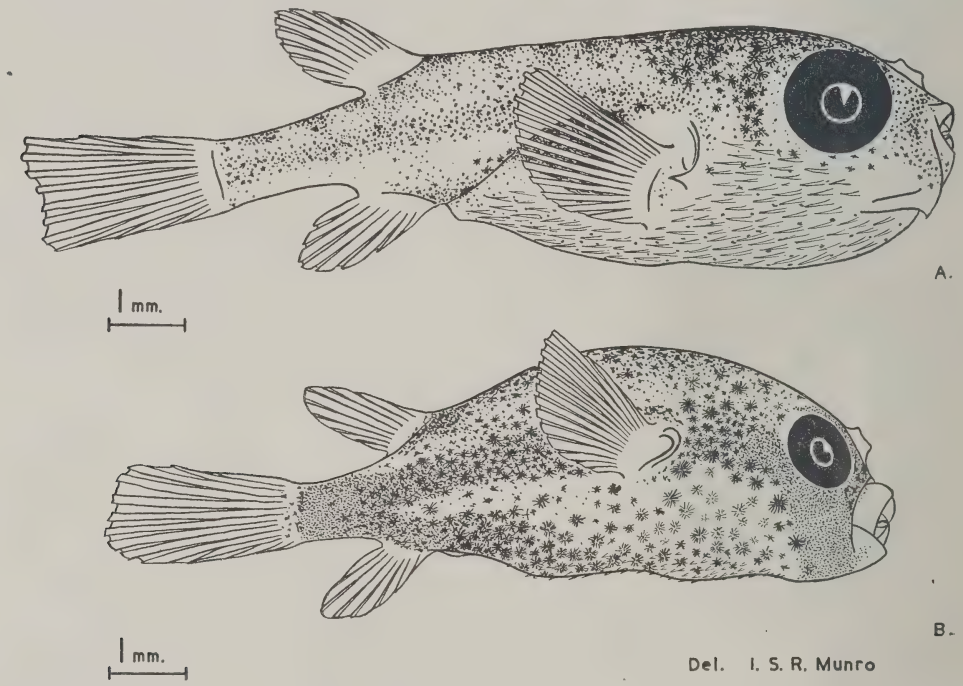
As indicated in the account dealing with the previous species, a few larvae, which, by virtue of their possession of an angular opercular spine can be identified as *Spheroides pleurogramma*, have been collected in the surface plankton of the Noosa River. All these were obtained near the mouth of that river, the first (1·8 mm.) being obtained on 7/8/44 and a further three examples (1·7 to 2·0 mm.) were collected on 17/9/44 together with a similar number identified as the preceding species *S. hamiltoni*. The spawning season appears shorter than that of this other species and is restricted to the late winter months of August and September. No eggs have been seen, but it is thought that they are probably demersal.

A newly hatched larva, measuring 1·7 millimetres in length, was amongst the September collection and is illustrated in text fig. 7B. In shape and size it closely resembles those of *S. hamiltoni* but is very different in its pigmentation. The head is naked except for a few dark cells situated behind the eyes. Instead of several rows of stellate cells, the caudal flank pigment is in the form of an intense, brownish black band formed from the matting together of the fine processes of spider-like cells. The yolk-sack is completely invested with large numbers of very small, stellate, black cells and these are considerably smaller than those of similar disposition in *S. hamiltoni*. Some of these cells extend on to the ventral part of the trunk somites and are particularly intense around the hind-gut.

In older larvae (text figs. 7C and 7D) the prominent band of caudal pigment completely disappears. The stellate cells of the yolk-sack proliferate and form an intensely black pigmentation on the skin adjacent to the visceral cavity. At a length of 2·0 millimetres there appear large, stellate, black cells on the operculum behind the eye and on the snout and back (text fig. 7C). With continued growth to a size of 3·2 millimetres (text fig. 7D) this pigment spreads

and forms an intensely black band which starts at the anus, covers the visceral cavity and the operculum, and extends past the eye on to the nape of the head. Posterior to this band there is no pigment on the body or fins. Also anterior to it is a small, unpigmented area around the maxillary and mandibular regions.

The smallest postlarva collected in the seine net was one of several that were netted on a sandy bottom near the mouth of the Noosa River on October 13th, 1944. It measures 12·5 millimetres and is illustrated in text fig. 8A. The opercular spine is quite prominent and a thick coating of dermal spines, each longer than those of *S. hamiltoni,* is present on the belly and cheek regions. The fin formula is typical of this species, being D. 10; A. 8; P. 15.



Text-fig. 8.—

A.—Post-larval *Spheroides pleurogramma* (Regan). From a specimen 12.5 mm. long.

B.—Post-larval *Spheroides hamiltoni* (Richardson). From a specimen 10.5 mm. long.

The pigmentation pattern already foreshadows that characteristic of adults. The back is covered with large numbers of small, blackish cells arranged in dense groups alternating with more lightly pigmented areas. This dorsal network soon begins to assume the appearance of irregular white spots on a ground of darker brown colour. The dark, longitudinal, side stripe of the adult pattern is already present. The more anterior of the two dark, dorsally transverse cross-bands is present in the form of a thick cluster of large cells above the origins of the pectoral fins. Another concentration of large cells behind the eye precedes the development of the five or six subvertical dark cheek stripes.

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NEW SPECIES OF LEPIDOPTERA FROM THE BARNARD COLLECTION. NO. 3.

By A. Jefferis Turner, M.D., F.R.E.S.

Family NOCTUIDAE.

Sub-Family Erastriainae.

Gen. Toana Wlk.

Cat. Brit. Mus. XXXII, p. 500. Hmps. Cat. Lep. Phal. X, p. 204.

Type *T. semiochrealis* Wlk. from Borneo. A small Indo-Malayan genus with one African species.

Toana thioptera n.sp.

θειλοπτερος, sulphur-winged.

♂ ♀. 15-16 mm. Head orange-yellow. Palpi 3, second joint expanded with loose hairs at apex; orange-yellow. Antennae pale grey; in male dentate to four-fifths, dentations 1, slender. Thorax and abdomen pale yellow. Legs orange-yellow; posterior pair paler. Forewings triangular, costa nearly straight, apex obtusely pointed, termen slightly rounded, slightly oblique; pale yellow; transverse lines and costal and terminal margins orange-yellow; lines nearly straight, feebly dentate, first at one-third, second at two-thirds occasionally the terminal line contains a few blackish scales; cilia pale yellow, apices pale grey. Hindwings with termen rounded; pale yellow; cilia as forewings.

Cape York in April and May; eight specimens.

Toana anomosema n.sp.

ἀνομοσημος, unusually marked.

♂. 15-17 mm. Head white. Palpi 1 and a half, second joint expanded towards apex, terminal joint hidden; pale brownish. Antennae grey, towards base white; ciliations in male 1. Thorax fuscous, anteriorly white. Abdomen whitish; tuft ochreous-tinged. Legs whitish; anterior pair grey. Forewings triangular, costa almost straight. Apex pointed, termen slightly rounded, oblique; fuscous with white markings a broad subcostal streak from base to two-thirds; a broad line before middle, curved sharply dorsad from subcostal streak to below middle of disc, thence turned upwards to touch the extremity of this streak before ending on costa near apex; enclosed between these streaks is a median fuscous dot; a submarginal line from costa near apex, at first slender, gradually becoming broader before it ends at tornus; some dark fuscous terminal dots; cilia grey with dark points. Hindwings with termen rounded grey cilia grey.

North Queensland: Cape York and Cooktown in April; two specimens.

Gen. Goniophylla nov.

γονιοφυλλος, with angled wings.

Tongue present. Palpi long, porrect, second joint thickened with appressed scales, terminal joint minute. Thorax with small smooth rounded posterior crest. Abdomen without crests. Posterior tibiae smooth. Forewings without areole, 2 from three-fourths, 3 from before angle, 4 and 5 approximated from angle, 6 from below upper angle, 7 from cell, 8 and 9 stalked, 10 and 11 from cell, free. Hindwings with 3 and 4 stalked, 5 from slightly below middle, straight, 6 and 7 connate, 12 anastomosing with cell near base.

Goniophylla fragilis n.sp.

fragilis, frail.

♀. 14 mm. Head grey-whitish. Palpi 3; grey-whitish. Antennae grey. Thorax grey; patagia and tegulae grey-whitish. Abdomen pale grey; a widely separate pair of dark fuscous dots on dorsum of second segment. Legs whitish. Forewings triangular, costa nearly straight, slightly sinuate, apex pointed, termen sharply angled on vein 4, above this concave, beneath straight, wavy; whitish suffused with grey; markings fuscous, obscure; a dot or small triangle on one-third costa representing antemedian line; a median shade from costa just beyond middle, containing two dots placed transversely; a slender line from costa shortly after this, at first outwardly oblique, soon sharply angled inwards, becoming obsolete beneath angle; a whitish submarginal line, distinct only towards costa; a dark interrupted terminal line; cilia whitish, apices grey. Hindwings with termen dentate; colour, terminal line, and cilia as forewings; a broad dark fuscous fascia from three-fourths dorsum, not reaching middle of disc.

North Queensland: Cape York in October; one specimen.

Gen. Asaphes nov.

ἀσαφης, obscure.

Tongue present. Palpi ascending, reaching middle of face; second joint thickened with appressed scales; terminal joint minute. Antennae in male simple. Thorax with a small median posterior crest. Abdomen without crests. Posterior tibiae smooth. Forewings without areole, 2 from near angle, 3 and 4 approximated from angle, 6 from near upper angle, 7 separate, 8 and 9 stalked, 10 and 11 from cell, free. Hindwings with 2 from four-fifths, 3 and 4 long-stalked from angle, 5 from above angle, 6 and 7 approximated from upper angle, 12 anastomosing with cell to beyond middle.

Asaphes asemantica n.sp.

ἀσημαντικος, undistinguished.

♂ ♀. 13-15 mm. Head, palpi, and antennae grey. Thorax and abdomen grey mixed with fuscous. Legs grey; posterior pair whitish. Forewings elongate-triangular, costa slightly arched, apex round-pointed, termen rounded, slightly oblique; grey with local whitish suffusions and dark fuscous lines; first line incompletely developed, from midcosta, bent inwards above middle, thence wavy to mid-dorsum, preceded by whitish suffusion; second line interrupted or incom-

plete, wavy, from two-thirds costa to two-thirds dorsum, followed by whitish suffusion; a terminal series of dark fuscous dots; cilia whitish-grey. Hindwings with termen rounded; grey; cilia pale grey.

North Queensland: Cape York in April; two specimens.

Gen. Paurosceles nov.

παυροσκελης, small-legged.

Tongue present. Palpi ascending, reaching about middle of face; second joint triangularly thickened towards apex; terminal joint short. Antennae of male ciliated. Thorax smooth. Abdomen with small dorsal crests on first and second segments. Midtibiae of male clothed with long hairs, which form a strong terminal tuft; posterior tibiae of male much reduced in size, slightly hairy, with two pairs of well-developed spurs. Forewings without areole, 2 from three-fourths, 3, 4, 5 approximated from angle, 6 from below upper angle, 7, 8, 9 stalked, 10 and 11 from cell, free. Hindwings with cell one-half, 2 from four-fifths, 3 and 4 stalked, 6 and 7 connate, 12 anastomosing with cell near base.

Paurosceles geminipuncta n.sp.

geminipunctus, twin-spotted.

♂. 20 mm. Head and thorax orange-yellow. Palpi 1 and a half orange-yellow. Antennae pale yellow, towards apex grey; ciliations in male 1. Abdomen pale yellow. Legs orange-yellow; posterior pair whitish. Forewings triangular, costa nearly straight, apex rounded, termen slightly rounded, scarcely oblique; orange-yellow with white markings; a sub-basal costal dot; a fine interrupted line from one-third costa to mid-dorsum, indented beneath costa and above dorsum, angled outwards below middle; two transversely placed dots with blackish centres beneath costa at three-fifths; postmedian from three-fifths costa, curved posteriorly towards apex, before reaching this curved transversely, indented in middle, finally curved inwardly to tornus; a terminal series of blackish dots, each preceded by an adjacent white dot; cilia yellow. Hindwings with termen rounded; pale yellow; cilia pale yellow.

North Queensland: Cape York in April; one specimen.

Enispa phaeopa n.sp.

φαιωπος, dusky.

♂. 20 mm. Head dark fuscous. Palpi 1; dark fuscous. Antennae fuscous; in male serrate and minutely ciliated. Thorax dark fuscous; tegulae brown-whitish sprinkled with fuscous. Abdomen brownish. Legs fuscous; posterior pair ochreous-whitish. Forewings triangular, costa straight to near apex, apex pointed, termen bowed on vein 4; brown-whitish; markings and some irroration dark fuscous; a broad costal streak from base to one-third, followed by transverse oblong costal spots at middle and two-thirds; a large irregularly suffused blotch above tornus; a grey-whitish terminal area from apex to below middle; a terminal series of dots; cilia brown-whitish sprinkled with fuscous. Hindwings with termen strongly rounded; colour, terminal dots, and cilia as forewings; a discal dot at one-third; faint interrupted postmedium and subterminal lines.

Queensland: Toowoomba in Oct. March; one specimen.

ENISPA RHODOPLEURA n.sp.

ῥοδοπλευρος, with rosy costa.

♀. 15 mm. Head rosy. Palpi 2; pale rosy. (Antennae broken off.) Thorax whitish, anterior edge rosy. Abdomen pale grey. Legs ochreous-whitish; anterior pair rosy-tinged. Forewings triangular, costa straight to near apex, apex pointed, termen slightly rounded, oblique; whitish faintly rosy-tinged, a bright rosy streak from base to apex; markings dark fuscous; three minute dots representing antemedian line; a median subcostal discal dot; a faint median line from this to mid-dorsum; a finely dentate postmedian line at two-thirds, indented above dorsum; a terminal series of dots; cilia rosy. Hindwings with termen rounded; colour, terminal dots, and cilia as forewings; faint subterminal and submarginal lines.

North Queensland; Cape York in May; one specimen.

EUBLEMMA LATERICOLOR n.sp.

latericolor, brick-coloured.

♂ ♀. 20-22 mm. Head, thorax, and abdomen reddish-grey. Palpi and antennae pale grey. Legs pale grey; tarsi fuscous with white rings at apices of segments. Forewings triangular, costa straight, apex acute, slightly produced, termen bowed; reddish-grey; costal edge ochreous-whitish; a minute fuscous dot preceding antemedian line and another on this line representing orbicular; reniform larger and constricted in middle; antemedian commencing as a short oblique fuscous streak from one-third costa, thence obscure to one-third dorsum; postmedian commencing similarly before two-thirds of disc, there strongly bent and straight to two-thirds dorsum; subterminal commencing similarly, but continued by a series of fuscous indented above dorsum; a submarginal series of dots; an ochreous-whitish terminal line; cilia reddish-fuscous. Hindwings with termen rounded; as forewings but without antemedian line and discal dots.

North Queensland: Cape York and Cooktown in November; four specimens.

EUBLEMMA COMPSOPREPES n.sp.

κομψοπρεπης, dainty-seeming.

♀. 16 mm. Head, palpi, and antennae pale brown. Thorax and abdomen grey-whitish. Legs whitish. Forewings triangular, costa straight, apex pointed, not produced, termen rounded, slightly oblique; grey-whitish; three blackish or brownish costal dots at one-fourth, middle, and three-fourths; from the first of these a very fine fuscous irregularly dentate line to one-fourth dorsum, from the second a strongly outwardly oblique line, angled at about one-fourth of breadth of disc, thence straight to mid-dorsum, above angle scarcely traceable, beneath angle thickened and brownish; three whitish costal dots before apex; an apical brownish spot giving off a very fine fuscous dentate submarginal line; cilia grey-whitish. Hindwings with termen rounded; colour and cilia as forewings; a straight brownish transverse line from mid-dorsum, not reaching costa.

North Queensland: Cape York in May; two specimens.

Eublemma perinephela n.sp.

περινεφελος, overclouded.

♀. 14-16 mm. Head, thorax, and palpi white. Antennae whitish-grey. Abdomen grey-whitish. Legs whitish. Forewings elongate-triangular, costa nearly straight, slightly sinuate, apex pointed, termen slightly rounded, strongly oblique; white; a faintly suffused pale ochreous outwardly oblique bar from one-third dorsum to about middle of disc; a narrow fuscous-grey terminal band, faintly edged with pale ochreous anteriorly; cilia white, on apex fuscous-grey. Hindwings with termen rounded; white; cilia white.

Queensland: Duaringa in January; Injune in October and December; three specimens.

Catoblemma brevipalpis n.sp.

brevipalpis, with short palpi.

♂ ♀. 15-20 mm. Head ochreous-whitish or grey-whitish. Palpi in male 1 and a half, in female 2, second joint with loose projecting hairs towards apex above, terminal joint minute; grey. Antennae whitish; ciliations in male 2. Thorax whitish-grey. Abdomen and legs ochreous-whitish. Forewings triangular, costa slightly sinuate, apex pointed, not produced, termen rounded, slightly oblique; ochreous-whitish more or less suffused with grey and faintly pinkish-tinged, usually darker between lines; antemedian and postmedian lines slender, whitish, obscure or obsolete, the latter from two-thirds costa to tornus, strongly curved outwards above middle and sometimes containing a pale fuscous spot in curve; a nearly straight line of irregular dark fuscous dots from apex to tornus, diminishing in size towards tornus; cilia grey. Hindwings with termen rounded; whitish; cilia whitish.

This species is exceedingly similar to the following in the forewings, though they have differently formed apices, but the palpi and antennal ciliations are very different.

North Queensland: Cape York in October. Queensland: Duaringa in September; three specimens.

Catoblemma punctilinea n.sp.

punctilineus, with dotted line.

♂ ♀. 17-22. Head whitish. Palpi 3, rather slender, terminal joint one-fifth; ochreous-whitish. Antennae whitish-grey; ciliations in male minute. Thorax whitish-grey, patagia ochreous-tinged. Abdomen grey more or less mixed with whitish. Legs ochreous-whitish. Forewings triangular, costa straight, apex acute, slightly produced, termen rounded, slightly oblique; whitish tinged with ochreous (or in one example with dull reddish) except towards costa and termen; antemedian line usually obsolete; postmedian pale fuscous, very slender, from two-thirds costa to before tornus, outwardly curved in upper half preceded by a slender pale fuscous transversely oval ring representing reniform; a subterminal line of dark fuscous dots diminishing in size towards tornus, those near apex sometimes confluent; cilia whitish or greyish. Hindwings with termen rounded; whitish, sometimes greyish or reddish.

North Queensland: Cape York in April. Queensland: Duaringa in September; three specimens.

Gen. TECHNEMON nov.

τεχνημων, artistic.

Face with small conical prominence. Tongue present. Palpi long, ascending, exceeding vertex; second joint very long, triangularly thickened at apex by a strong posterior tuft; terminal joint concealed. Antennae in male shortly ciliated. Thorax with rounded posterior crest. Abdomen without crests. Posterior tibiae hairy on dorsum. Forewings without areole, 2 from $\frac{3}{4}$, 7, 8, 9 stalked, 10 and 11 from cell, free. Hindwings with 2 from near end of cell, 3 and 4 stalked, 5 somewhat approximated, 6 and 7 stalked, 12 anastomosing with cell to middle.

TECHNEMON EPICHARES n.sp.

ἐπιχαρης, pleasing.

♂ ♀. 16-18 mm. Head, palpi, and thorax dark fuscous. Antennae fuscous; ciliations in male $\frac{1}{2}$. Legs fuscous with whitish rings; posterior tibiae whitish-ochreous. Forewings elongate-triangular, costa gently arched, apex rounded, termen slightly rounded, oblique; fuscous with blackish transverse lines; sub-basal straight, suffused; antemedian from $\frac{1}{4}$ costa to $\frac{2}{5}$ dorsum, slender, wavy; postmedian from $\frac{2}{3}$ costa, soon bent outwards, thence transverse to middle, where it is bent inwards and sinuate to $\frac{2}{3}$ dorsum, edged posteriorly with whitish; a dentate widely interrupted white subterminal line; a blackish spot above tornus; a white terminal suffusion beneath apex; a blackish submarginal line; cilia fuscous, suffused or barred with white on apex. Hindwings with termen rounded; ochreous-yellow; a dark fuscous terminal band; cilia fuscous, apices ochreous-whitish.

Queensland: Injune in September and October; four specimens.

CORGATHA IMPLEXATA.

Wlk. xxiv. p. 1090. Hmps. x. p. 300.

♂ ♀. 20-21 mm. Head white; face dark red. Palpi 2; dark red. Antennae white in basal third, thence pale ochreous-grey; in male with a small tuft of scales on dorsum at one-third, ciliations 1 and a half. Thorax reddish. Abdomen reddish; tuft pale ochreous. Legs pale ochreous; anterior pair dark red; in male anterior coxae and femora and all tibiae clothed in dense hairs. Forewings triangular, costa straight almost to apex, apex pointed, termen gently rounded, oblique; dull reddish; a white costal streak interrupted by three or four reddish dots; a minute fuscous discal dot; a postmedian series of fuscous dots, each edged white anteriorly, from three-fifths costa first outwardly and then inwardly curved to two-thirds dorsum; a terminal series of blackish dots; cilia reddish. Hindwings with termen strongly rounded; colour and markings as forewings.

North Queensland: Cape York in November (W. B. Barnard); five specimens.

Corgatha miltopolia n.sp.

μιλτοπολιος, reddish-grey.

♂. 26 mm. Head whitish-grey. Palpi 2 and a-half, obliquely ascending, crest on dorsum of second joint slightly developed, terminal joint porrect, short, but longer than in allied species; whitish-grey. Antennae grey; ciliations in male 1. Thorax reddish. Abdomen white, not crested, but with reddish median dots on dorsum of first three segments; dorsum of tuft purple-reddish. Legs reddish-grey. Forewings triangular, costa straight, to two-thirds, thence gently arched, apex acute, termen concave beneath apex, acutely angled on vein 3, thence oblique; dull reddish with a few blackish scales, partly suffused with grey; two white discal spots partly outlined with dark fuscous, first at one-fifth, suboblong, second at two-fifths, oval; costal edge grey; an obscure transverse grey line at one-fourth; space between discal dots and costal part of postmedian band grey; anterior edge of band formed by a wavy grey line from two-fifths costa to three-fifths dorsum, posterior by a similar line midway between this and termen; a submarginal series of blackish dots; cilia white. Hindwings with termen strongly rounded; white; a submarginal series of fuscous dots; cilia white.

North Queensland: Cape York in October and March; two specimens.

Gen. Proschora nov.

προσχωρος, adjoining.

Tongue present. Face not projecting. Palpi ascending, reaching middle of face; second joint rather slender, rough-scaled; terminal joint short. Thorax with a moderate posterior crest. Abdomen with a dorsal crest on basal segment. Posterior tibiae smooth. Forewings with areole narrow, 10 connate with 8, 9 from areole. Hindwings with 3 and 4 stalked, 5 from near angle of cell, 12 anastomosing with cell near base. Near *Metasada* Hmps.

Proschora amaura n.sp.

ἀμαυρος, obscure.

♂. 18 mm. Head, palpi, and thorax brown. Antennae grey. Abdomen pale grey. Legs whitish-ochreous; anterior pair fuscous with whitish-ochreous rings. Forewings triangular, costa slightly arched, apex subrectangular, termen slightly rounded, scarcely oblique; dull reddish-brown; reniform pale fuscous, obscure, rather large, transversely oval; postmedian line from three-fifths costa to two-thirds dorsum, very obscure, pale fuscous, curved outside reniform; cilia ochreous-whitish with median and terminal fuscous lines. Hindwings with termen slightly sinuate; grey; cilia ochreous-whitish with sub-basal grey line.

Queensland: Toowoomba in November; one specimen.

Oruza leucostigma n.sp.

λευκοστιγμος, with a white dot.

♀. 20 mm. Head brown-whitish; collar brownish-fuscous. Palpi whitish, second joint with base and an apical ring blackish. Antennae grey. Thorax and abdomen brown-whitish. Legs brown-whitish; anterior pair fuscous. Forewings triangular, costa straight, apex rounded, termen rounded, scarcely oblique; brown-whitish; a median white discal dot surrounded by a slight fuscous

suffusion; five blackish costal dots, at one-third, middle, and three between this and apex; a faint interrupted outwardly curved dark line from second dot to one-fourth dorsum; a similar line from fourth dot, inwardly sinuate to mid-dorsum; a subapical blackish dot connected by fuscous with an apical dot; from this a faint pale dentate subterminal line, interrupted at one-third by a fuscous dot; a terminal series of blackish dots; cilia brown-whitish sprinkled with a few fuscous scales. Hindwings with termen slightly rounded, crenulate; colour, terminal dots and cilia as forewings; a median sub-basal discal blackish dot; very faint pale dentate postmedian and subterminal lines.

North Queensland: Cape York in June; one specimen.

ORUZA ASPERSA n.sp.

aspersus, sprinkled.

♂. 21 mm. Head and palpi brown. Antennae grey; ciliations in male minute. Thorax and abdomen pale brownish. Legs ochreous-whitish; anterior pair fuscous. Forewings triangular, costa straight, apex pointed, termen rounded, oblique; pale brownish with blackish dots; six costal dots, at two-fifths, three-fifths, and four between the latter and apex; subcostal discal dots at one-fourth, middle, and two-thirds, with two in a line between the last and fifth costal dot; a submarginal series, those below middle minute; a terminal series; cilia pale brownish. Hindwings with termen rounded; colour and cilia as forewings; a discal dot at one-third; submarginal and terminal series of dots.

North Queensland: Cape York in April; one specimen.

LOPHORUZA MOLYBDOSTICHA n.sp.

μολυβδοστιχος, with leaden lines.

♂ ♀. 24-26 mm. Head and palpi reddish-grey. Thorax orange, anterior edge grey. Abdomen orange. Legs reddish-grey; posterior pair whitish-ochreous. Forewings triangular, costa straight to near apex, apex pointed, termen slightly rounded, slightly oblique; orange with slender grey leaden-metallic lines; a grey costal streak from base to apex; three bisinuate transverse lines; at one-fourth, from two-fifths costa to middorsum, and from two-thirds costa to three-fourths dorsum; a grey postmedian line without metallic lustre; a grey leaden-metallic subterminal line with obtuse grey interneural projections not reaching termen; a series of submarginal blackish lunules narrowly separated from an interrupted blackish terminal line; cilia pale reddish-grey. Hindwings with termen rounded; as forewings but with only three metallic lines.

North Queensland: Cape York and Cooktown in April; two specimens.

LOPHORUZA CHALCOCOSMA n.sp.

χαλκοκοσμος, with brassy ornament.

♂. 25 mm. Head and thorax brown. Palpi slightly over 1; brown. Antennae brownish-grey; ciliations in male 1. Abdomen reddish-brown; large rounded dorsal crests on second and fourth segments, almost touching; dark fuscous with brassy lustre. Legs whitish-ochreous. Forewings triangular, costa slightly arched, apex obtusely pointed, termen rounded, slightly oblique; whitish

FOSSIL VERTEBRATES FROM GORE QUARRIES.

By H. A. Longman (Director).

Many fragments of fossil vertebrates have recently been received from cave fillings at the Gore Limestone Quarries, South-Western Line, Queensland. Mr. L. C. Ball, Chief Geologist, Geological Survey of Queensland, heard of the occurrence of fossil bones at Gore whilst enquiring for phosphatic cave earths. In response to his request, Mr. D. S. Geary, manager of the Queensland Cement and Lime Co., forwarded specimens which Mr. Ball kindly brought to me in April last. A second consignment was received from Mr. Ball shortly afterwards. Subsequently Flight-Sergeant E. T. O'Rourke personally collected numerous specimens and brought two boxes of material to the Museum.

This new fossil locality appears to be even richer than the Marmor Quarry cave-earth deposits, many specimens from which were recorded by the writer in Vol. VIII. of these Memoirs. Only part of this material from Gore has yet been examined in detail. There are dozens of maxillary and mandibular fragments of Macropodidae, with scores of long-bones, pelvic and tarsal elements, some of which are very fragmentary and some almost perfect. The following concise identifications will show that some of the specimens are of unusual interest:—

Thylacoleo carnifex Owen. Mandibular fragment with carnassial and incisor; another mandibular fragment with carnassial; incomplete specimens of two unattached carnassials. F. 2770.

Sarcophilus laniarius Owen. Six mandibular fragments; one maxillary fragment with two worn molars; one isolated 2nd molar from the right maxilla. F. 2771.

Phascolonus gigas Owen. Two mandibular fragments and two isolated molars. F. 2772.

Phascolomys mitchelli Owen. Abraded fragment of a mandible with remains of the molar series, the dimensions of which agree with those of *P. mitchelli*. F. 2774.

Bettongia sp. (Sub-Family Potoroinae). A slightly-disrupted mandibular fragment with the characteristic deciduous premolar and two following molars. F. 2775.

Isoodon obesulus. Three multicuspidate quadrangular molars were found completely embedded in cave earth but perfectly preserved and in serial alignment, 10 mm. in length. These agree precisely with unworn molars of this common bandicoot. F. 2773.

No precise identifications have yet been made of the numerous maxillary and mandibular fragments of Macropodidae.

A single isolated incisor of the *Rattus* type shows the presence of rodent species.

The proximal end of an avian tarso-metatarsus is closely comparable with that of *Alectura lathami*, the Brush Turkey. F. 2769.

The fragment of a lower jaw demonstrates a large Scincoid lizard resembling *Trachysaurus rugosus*.

The presence of the Marsupial Lion (*Thylacoleo*), the "Marsupial Devil" (*Sarcophilus*) and the "Giant Wombat" or "Pouched Ass" (*Phascolonus*) shows that the Gore Quarries fauna is obviously related to that of the extensive Condamine Pleistocene deposits to the north of this locality. Mr. Ball notes that the limestones "are believed to be of Carboniferous Age."

A. H. Tucker, Government Printer, Brisbane.

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